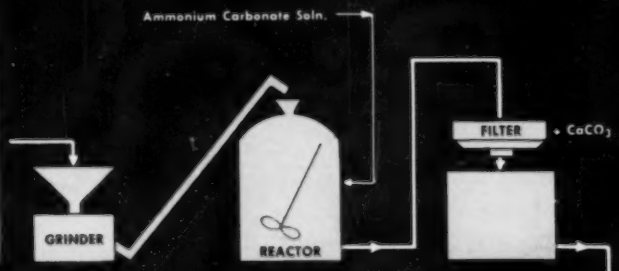
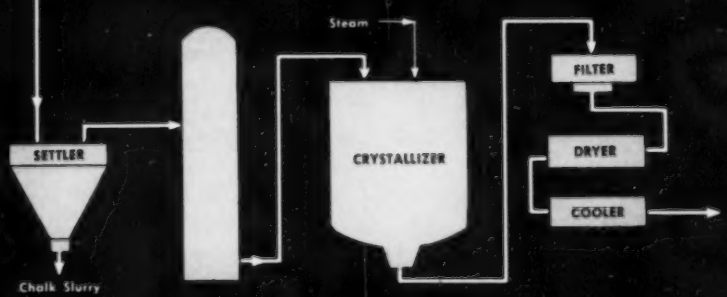
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# Chemical Engineering






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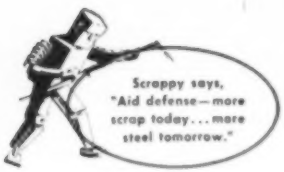
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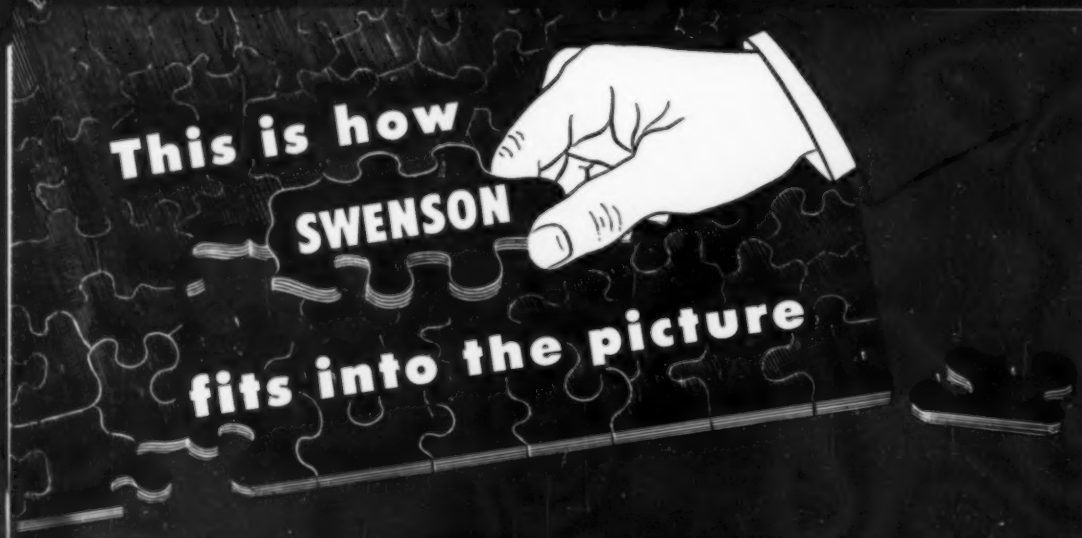
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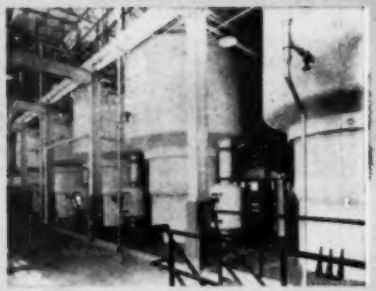
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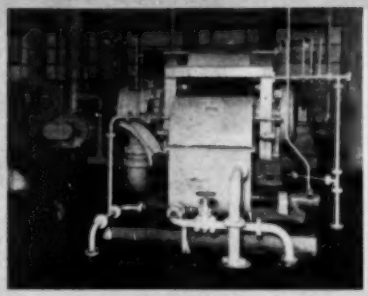
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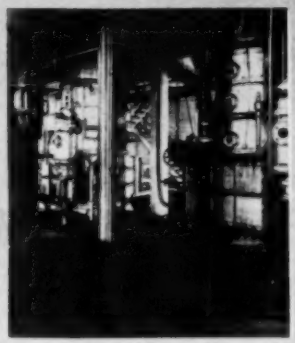
*First four effects of Swenson 7-Body L.T.V. Quintuple Effect Beet Sugar Evaporator*



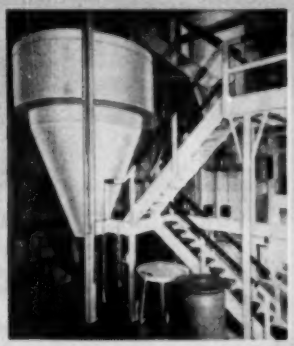
*Swenson Rotary Drum Vacuum Filter used for spin bath recovery in rayon-cellophane production*



*Swenson Forced Circulation Evaporator used for recovering organic materials*



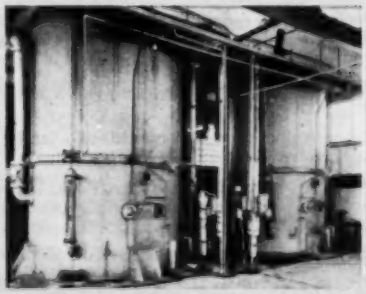
*Swenson Cast Lead Evaporators used for the concentration of phosphoric acid*



*Swenson Spray Dryer used in manufacturing pharmaceutical products from process wastes*



*A battery of six Swenson-Nyman Pulp Washers used in producing kraft paper*



*Swenson Vacuum Crystallizers precipitate Glaubers' salt from acid solution*

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**Extrusions available** – solid bar stock, 10′ lengths, 3/16″ to 1½″ in diameter. Pipe in standard iron pipe sizes ½″ to 4″ i.d., 10′ and 20′ lengths . . . can be threaded with ordinary pipe dies.

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**Fittings and valves** – complete catalog available soon.

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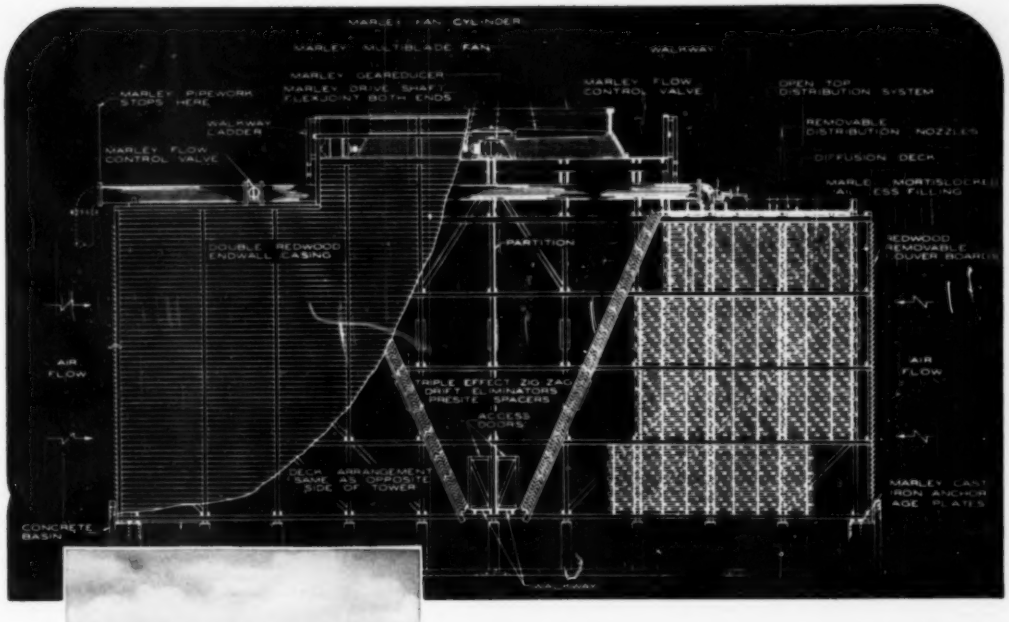
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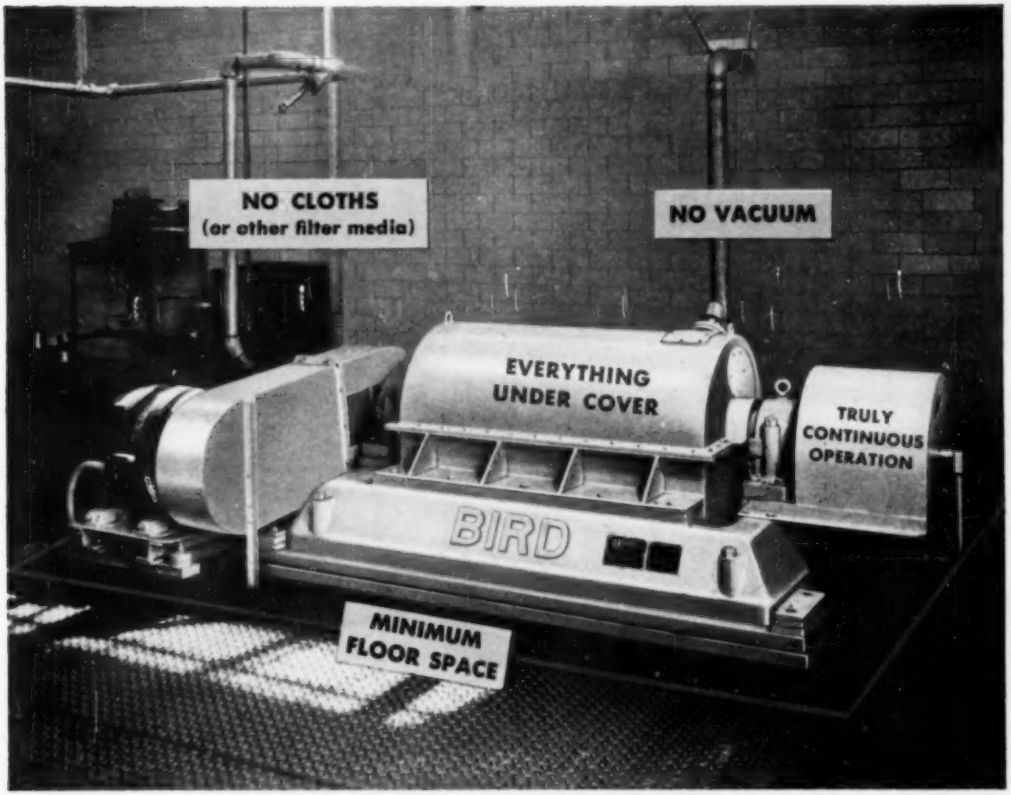
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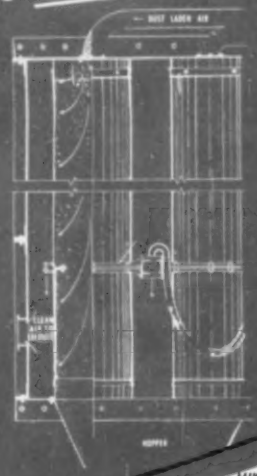
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## IT'S IDEAL FOR YOUR MOST HAZARDOUS JOBS



*Sectional view of MIKRO-COLLECTOR showing felt filter bags and reverse jet cleaning ring.*

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**Photo-micrographs illustrate value of wool felt as a superior filter medium.**

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12,737



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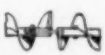
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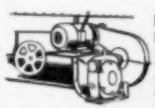
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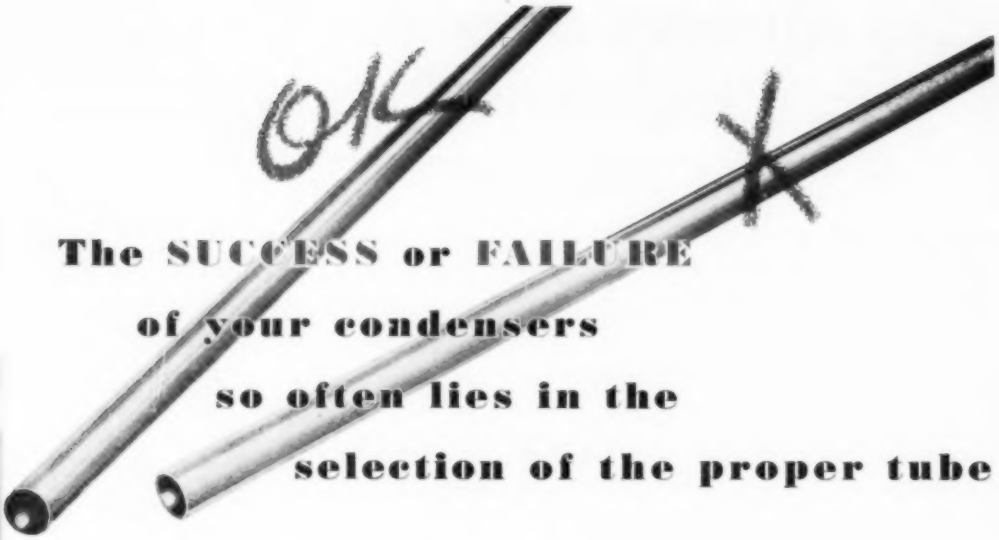


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After all, a tube — or actually a quantity of tubes — is charged with a large share of a condenser's function. Because so much depends upon the physical ability of the tube to "carry on", the selection of the tube—the right tube—is indeed of great importance.

When you select your tube, make sure it is of the proper copper base alloy to meet the conditions that prevail in your particular operations.

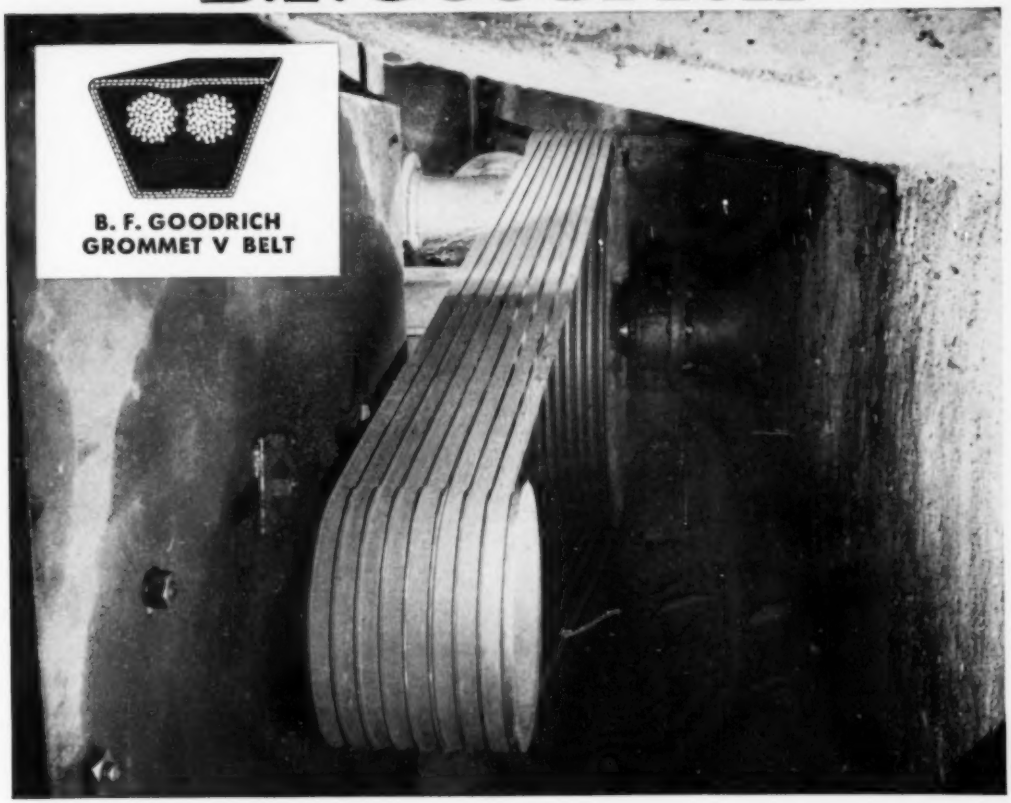
If you are not absolutely certain of the right alloy to use, or if you are interested in checking up on the latest developments in tubes for condenser operations — and to learn about some of our laboratory findings — we invite your correspondence.

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# B.F.Goodrich grommet belts saved $250.00 a year

***B. F. Goodrich grommet V belts cut costs 20 to 50%***

THESE belts have to run 24 hours a day under terrific tension. Ordinary V belts used to snap in two, fly off this drive in only 4 months. In September 1950, B. F. Goodrich grommet belts were installed. They have already lasted 4 times as long as previous belts, still look good, and are saving over $250.00 a year in replacement costs. Here's why B. F. Goodrich grommet belts can be counted on to save on belt costs:

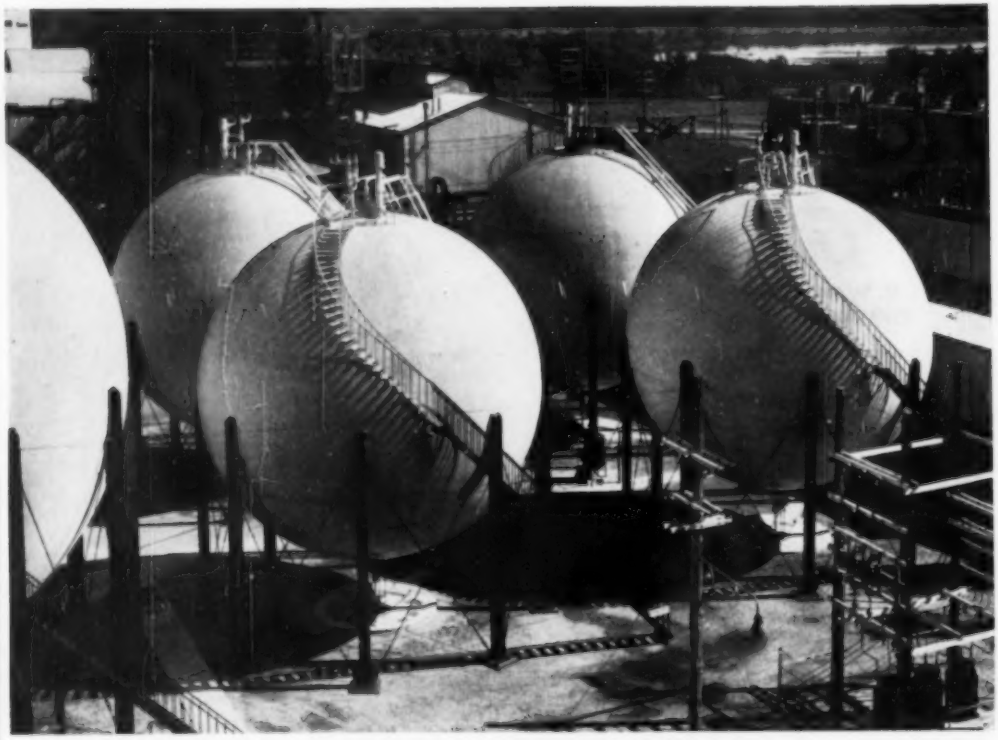
*No cord ends*—A grommet is endless, made by winding heavy cord on itself to form an endless loop. It has no overlapping ends. Because most of the failures in ordinary V belts occur in the region where cords overlap, the endless cord section in a grommet V belt eliminates such failures.

*Concentrated cord strength*—All of the cord material in a B. F. Goodrich grommet multiple-V belt is *concentrated* in twin grommets, positioned close to the driving faces of the pulley. No layers of cords to rub against one another and generate heat; cord and adhesion failures are reduced.

*Better grip, less slip*—Because a grommet is endless, a grommet V belt is more flexible, grips the pulleys better. Size for size, grommet multiple-V belts will give ⅓ more gripping power, pull heavier loads with a higher safety factor.

*Only B. F. Goodrich has the grommet!*—No other multiple-V belt is a grommet V belt (U. S. Patent No. 2,233,294). Now available in C, D and E sections. See your local B. F. Goodrich distributor. *The B. F. Goodrich Company, Industrial & General Products Division, Akron, Ohio.*

*Grommet V Belts* BY
**B.F.Goodrich**
RUBBER FOR INDUSTRY



## Spencer Chemical Company Stores Ammonia Under Pressure

It pays the Spencer Chemical Company to store ammonia under pressure in Hortonspheres at its Pittsburg, Kan. plant . . . because it greatly reduces storage costs of this valuable commercial product.

Ammonia flowing from Spencer Chemical's synthesis equipment is cooled and then stored under 75 lbs. per sq. in. pressure in Hortonspheres. When the pressure in the tanks exceeds the setting of the relief valves, the vapor vented is re-condensed and pumped back in the Hortenspheres.

Also in service at Spencer Chemical Company's Pittsburg plant are three 120-ft. by 40-ft. cone roof tanks and a 35-ft. diam. by 28-ft. aluminum tank storing 83 per cent ammonium nitrate solution.

Horton tanks are built to fit almost every storage requirement in the chemical industry. We can fabricate structures from carbon steel or corrosion-resistant metals . . . and we have facilities for x-raying and stress-relieving shop built structures.

Write our nearest office for information or quotations. There is no obligation on your part.

### Natural Gas . . . a basic ingredient at Spencer Chemical Company

At its Pittsburg, Kansas, plant, Spencer Chemical Company produces huge quantities of ammonia, ammonium nitrate, methyl alcohol, and dry ice—all from just natural gas, steam and air. The important role of natural gas in production processes is emphasized by the quantity used . . . up to 45 million cubic feet per day. From $10 worth of natural gas, Spencer Chemical Company can produce $140 worth of nitrate fertilizer.

# CHICAGO BRIDGE & IRON COMPANY

| | | | | | |
|---|---|---|---|---|---|
| Atlanta 3 | 2120 Healey Bldg. | Detroit 26 | 1503 Lafayette Bldg. | Philadelphia 3 | 1625—1700 Walnut St. Bldg. |
| Birmingham 1 | 1510 North Fifteth St. | Havana | 402 Abreu Bldg. | San Francisco 4 | 1522—200 Bush St. |
| Boston 10 | 1005—201 Devonshire St. | Houston 2 | 2103 C & I Life Bldg. | Seattle 1 | 1305 Henry Bldg. |
| Chicago 4 | 2124 McCormick Bldg. | Los Angeles 17 | 1505 General Petroleum Bldg. | Tulsa 3 | 1623 Hunt Bldg. |
| Cleveland 15 | 2220 Guildhall Bldg. | New York 6 | 3318—165 Broadway Bldg. | Washington, D. C. | 1160 Cafritz Bldg. |

Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PENNSYLVANIA



## Her fingertips imagine the taste

The lady doesn't trust her eyes alone.

The buyer of Multiwalls is in much the same position.

Aside from package design, it's hard to tell one manufacturer's bag from another's simply by looking at it or fingering it.

Put the bags out of sight and you may be able to see many differences.

Men who buy 85 percent of all Multiwalls consider* these intangibles more important than any other factor when they choose their supplier.

Invariably, these are among the first questions they ask . . .

"It this company big enough?"

"Do they have a fair allocation policy?"

"Are their prices competitive?"

"Do they respect delivery dates?"

In a nutshell—

"Are they good people to do business with?"

We can't tell you what the answers are when these Multiwall users consider Union. This we do know . . . and the inference is yours to make—

In these days of industrial pressure, when *dependability* is a fervent wish as well as a word, men to whom Multiwalls are important are placing an increasing share of their orders with Union."

More so every day . . .

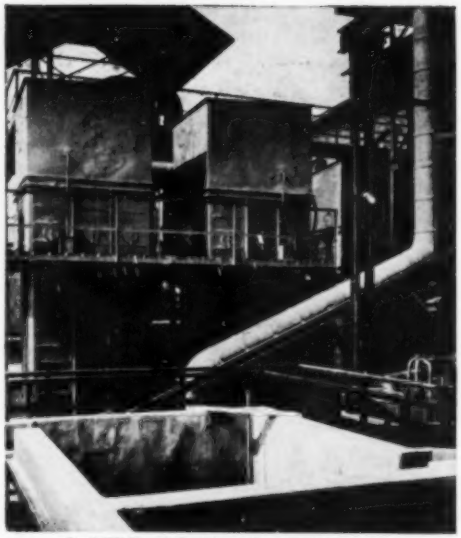
**IT'S UNION FOR MULTIWALLS**

TRADE MARK UNION

*August, 1951 research study.

UNION BAG & PAPER CORPORATION • NEW YORK: WOOLWORTH BUILDING • CHICAGO: DAILY NEWS BUILDING

# Valuable dust recovery should pay its own way



Buell 'SF' Electric Precipitator for collecting acid mist.



*A Buell industrial 'dust' man can show you how valuable dust recovery actually pays for itself in profits and plant efficiency.*

The Buell organization of industrial 'dust' men is devoted solely to the design and construction of dust recovery and dust collection equipment that will most efficiently and economically solve your plant's specific stack dust problem.

For more than 18 years we have been doing just this for all American industry. Every Buell installation is a custom designed system, engineered to hold stack dust discharge down to the practical limits which assure new profits, improved product and/or process, better plant-community relations, higher levels of employee morale.



For full information about Buell's **3 *basic systems*** of dust collection, and how one can be applied to the solution of your stack dust problems, write today. Ask for the new informative bulletin titled, "The Collection and Recovery of Industrial Dusts." Do it now. Buell Engineering Co., Dept. 12-F, 70 Pine Street, New York 5, N. Y.

ELECTRIC CYCLONIC

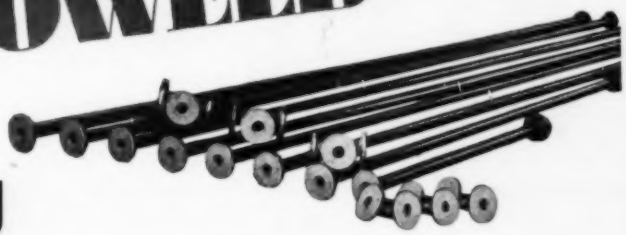
HIGH EFFICIENCY CYCLONES • ELECTRIC PRECIPITATORS
TYPE 'LN' COLLECTORS • LOW DRAFT LOSS COLLECTORS
SPECIAL PURPOSE COLLECTORS • DUST HOPPER VALVES

buell

ENGINEERED EFFICIENCY IN DUST RECOVERY

# You Can Save More with

# PLIOWELD



# Lined Piping

WHEREVER you handle corrosives, abrasive materials and other enemies of metal piping, it will pay you to investigate the savings you can make with PLIOWELD—Goodyear's lining material that bonds *permanently* to metal surfaces.

### 7 REASONS WHY
### THE G.T.M. SPECIFIES PLIOWELD

1 Effectively seals in corrosives that cannot be handled in metal

2 Bonds permanently to metal surfaces—an exclusive Goodyear process

3 Does not split or loosen with vibration or severe external impacts

4 Does not crack or buckle under alternate wetting and drying or under temperature changes

5 Surface will not disintegrate or slough off—*cannot ever contaminate in-process materials*

6 Protects product from discoloration, iron "pickup" and other contaminants

7 Each installation specially formulated to provide maximum protection against chemical handled

The G.T.M.—Goodyear Technical Man—will gladly discuss your problem—and recommend a PLIOWELD lining matched to your needs that will give you these benefits:

LOWER OVER-ALL COST because the useful life of PLIOWELD lined pipe so far exceeds unlined pipe that its slightly higher initial cost is more than made up by your savings in replacement outlays.

LOWER MAINTENANCE COST. Because PLIOWELD is absolutely impervious to corrosion, daily inspections and frequent maintenance shutdowns are eliminated. *The savings this means should cover the cost of* PLIOWELD *lining in a short time.*

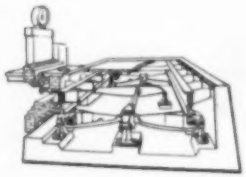
IMPROVED PRODUCTION where PLIOWELD lined pipes handle production items. Your product is protected against taint and discoloration because the lining won't slough off or contaminate liquids.

Ask the G.T.M. about PLIOWELD lined pipes, fittings and equipment—everything from laboratory equipment to rail tank cars—or write Goodyear, Akron 16, Ohio.

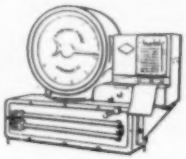
Pliowald—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

# GOODYEAR

**THE GREATEST NAME IN RUBBER**

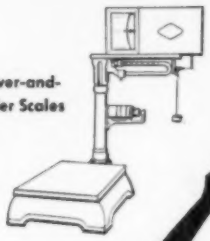


Truck Scales



Printomatic Dial Scales

Over-and-
Under Scales



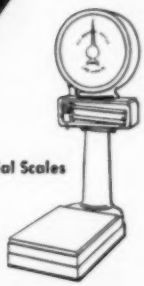


Type Registering Beam Scales

Bench Dial Scales



Portable Dial Scales

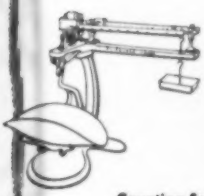


# Speeds your weigh!

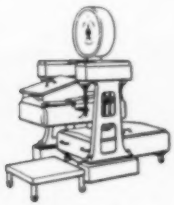
FAIRBANKS-MORSE,

*a name worth remembering*

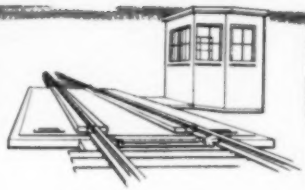
SCALES • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • PUMPS • HOME WATER SERVICE EQUIPMENT • RAIL CARS • FARM MACHINERY • MAGNETOS



Counting Scales

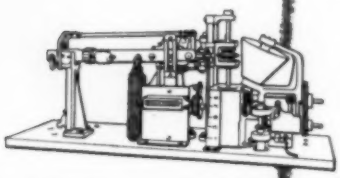


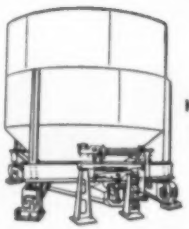
Weigh Can Scales



Railroad Track Scales

Belt Conveyor Scales





Hopper Scales

Fairbanks, Morse & Co., 600 South Michigan Avenue, Chicago 5, Illinois

# This kind of round-table discussion can HELP YOU GET YOUR PLANT UNDER WAY



Round-table discussion by our experts and your specialists can solve the problems necessary to get your chemical or industrial plant operating profitably. Chemical Plants Division engineers have practical "on-the-job" design and construction experience. By focusing the composite skills and experience of our engineers on your problem, we feel we can present you with better methods, better layouts, or better equipment to increase your production, reduce your costs, or make your project commercially feasible.

Development of a new process, expansion, conversion, or modernization of your present facilities, or designing and building a new plant . . . we are ready to discuss your problem with you.

**CHEMICAL PLANTS DIVISION**
***offers you competent experience in***

**Chemical Processes**—Processing plants designed and constructed in accordance with the client's data.

**Chlor-Alkali**—Complete chlorine and caustic soda plants employing the Mathieson mercury cell process.

**Fats and Oils**—Units for the extraction and processing of fats and oils into edible and industrial products.

**Low Temperature Processes**—Plants for the separation of gases into their components by processes of Gesellschaft fuer Linde's Eismaschinen.

**Oil and Gas**—Gas compressor and treating plants; facilities for distillation, cracking, reforming, polymerization and refining of petroleum.

**Resins and Plastics**—Plants to produce resins such as alkyd, phenolic, urea, melamine, vinyl, polystyrene, copolymer, and special resins.

**Synthetic Fuels and Chemicals**—Production of synthetic hydrocarbons and oxygenated compounds based on Fischer-Tropsch, Oxo, and Oxyl synthesis.

# CHEMICAL PLANTS

**DIVISION OF BLAW-KNOX CONSTRUCTION CO.**

930 DUQUESNE WAY, PITTSBURGH 22, PA.

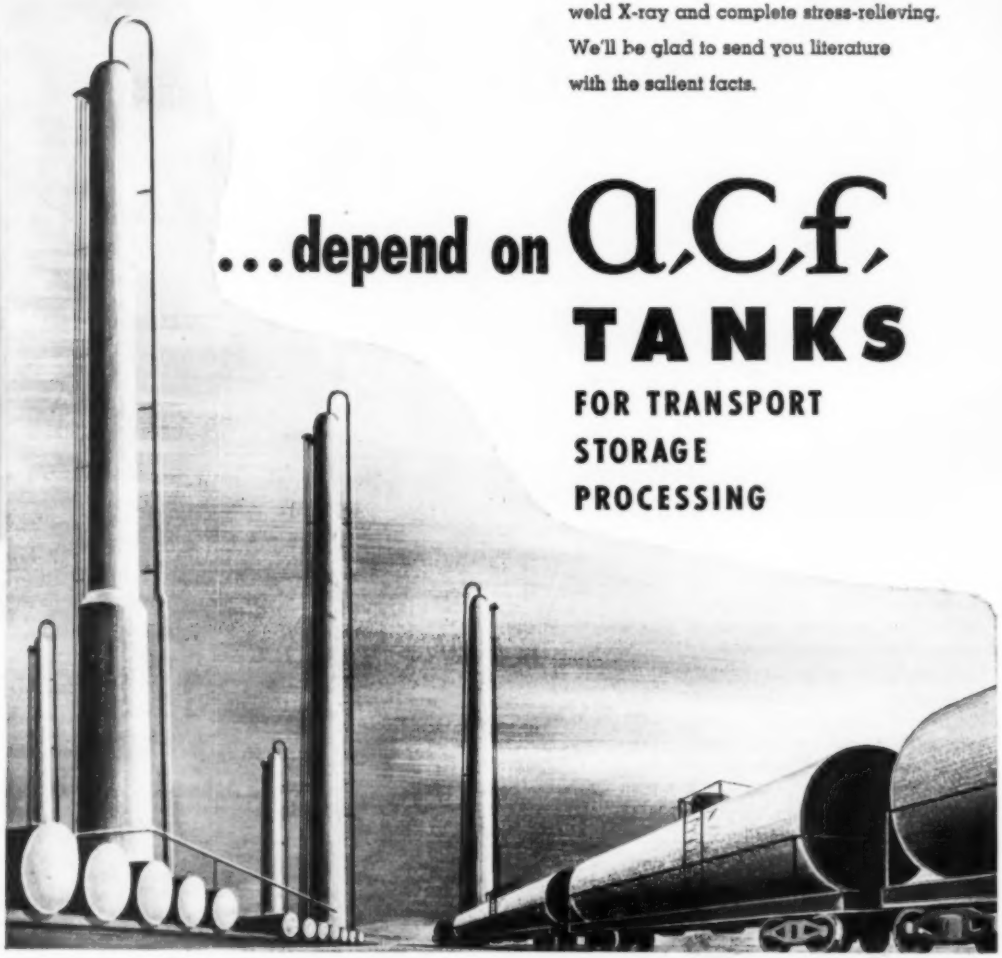
TULSA 1 • NEW YORK 17 • PHILADELPHIA 3 • CHICAGO 1
BIRMINGHAM 3 • WASHINGTON 5, D. C.

# when safety is imperative

a.c.f.-built tanks and safety valves set the quality standards of the industry...in railroad tank cars, storage tanks for pressure gases and liquids, and processing vessels. The highly skilled craftsmen in a.c.f. plants are matched only by their modern equipment for fabrication, inspection and testing. If safety is important, why take chances? With a.c.f., quality is proved through exacting weld X-ray and complete stress-relieving. We'll be glad to send you literature with the salient facts.

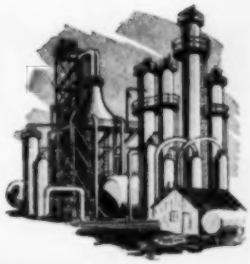
## ...depend on a.c.f. TANKS

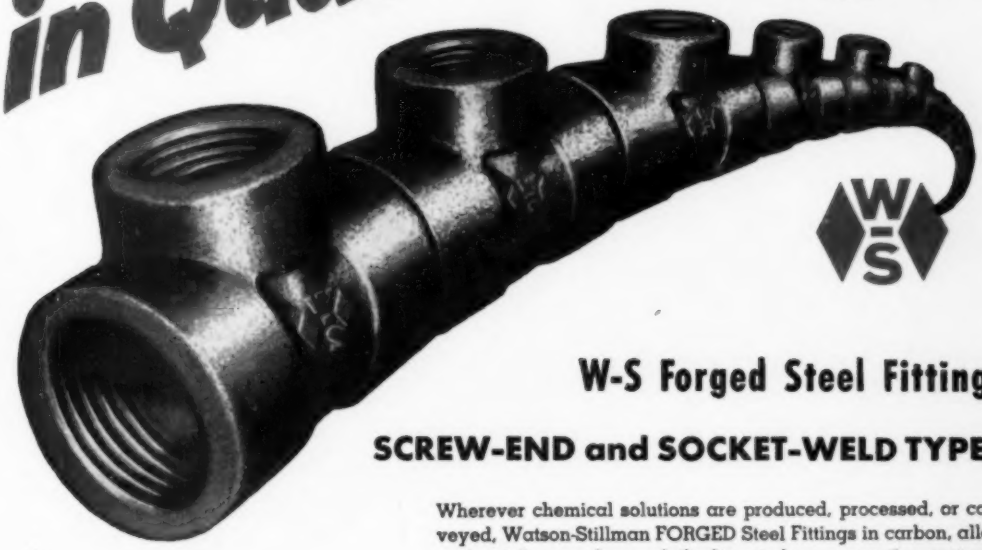
FOR TRANSPORT
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AMERICAN CAR AND FOUNDRY COMPANY • 30 CHURCH STREET, NEW YORK 8, NEW YORK
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# Quality... in Quantity





## W-S Forged Steel Fittings

### SCREW-END and SOCKET-WELD TYPES

Wherever chemical solutions are produced, processed, or conveyed, Watson-Stillman FORGED Steel Fittings in carbon, alloy and stainless grades mark the lines to lower operating cost and higher profits.

Quality—in Quantity—has earned and sustained the Watson-Stillman position of first-to-see when industry seeks a solution to a specific fittings problem. Despite an enormous increase in the use of its low *service* cost fittings, Watson-Stillman has never relaxed its concern for the metallurgical aspects of product development.

First to identify itself with the establishment of standards for the properties of special purpose fittings alloys, Watson-Stillman technicians continue in close association with the engineering research efforts of a score of basic industries . . . will be glad to lend a hand on *your* next fittings problem.



9-M-3

• **Stronger** • **Smaller** • **Lighter** • **Tighter**
• **More Uniform** • **Lower *Service* Cost**

**SOLD THROUGH LEADING DISTRIBUTORS . . . EVERYWHERE**

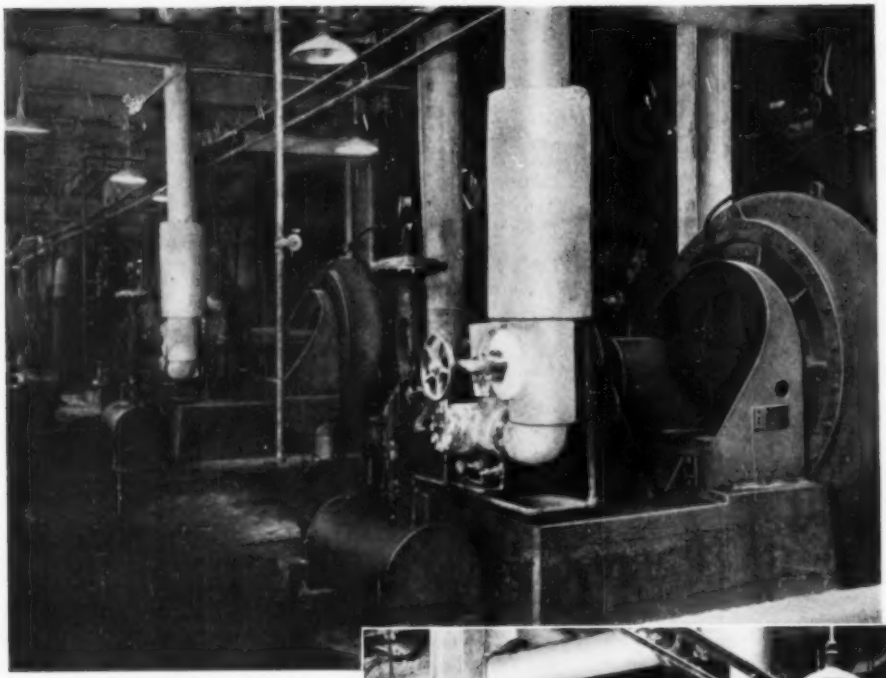
**DISTRIBUTOR PRODUCTS DIVISION**

**ROSELLE, NEW JERSEY**

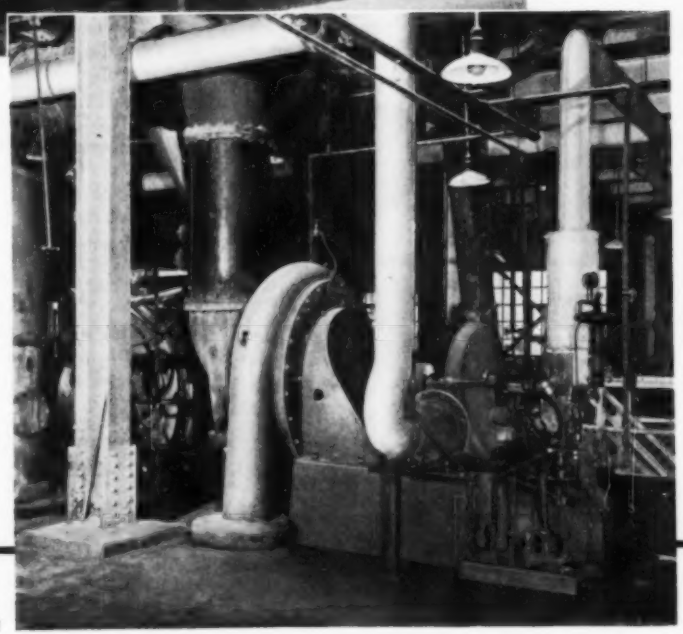
**WATSON-STILLMAN**
ESTABLISHED 1848

**Designers and Manufacturers of Forged Steel Fittings, Wire Rope Shears, Hand Pumps, Jacks, Pipe Benders and Hydraulic Equipment**

# Twenty years pulling



Part of the line of Elliott turbine-driven single-stage blowers serving continous filters at the Carlsbad plant.



Another view of the blower line. Discharge nozzles point down.

P2-2

# brine-laden air!

## ELLIOTT *Centrifugal* BLOWERS



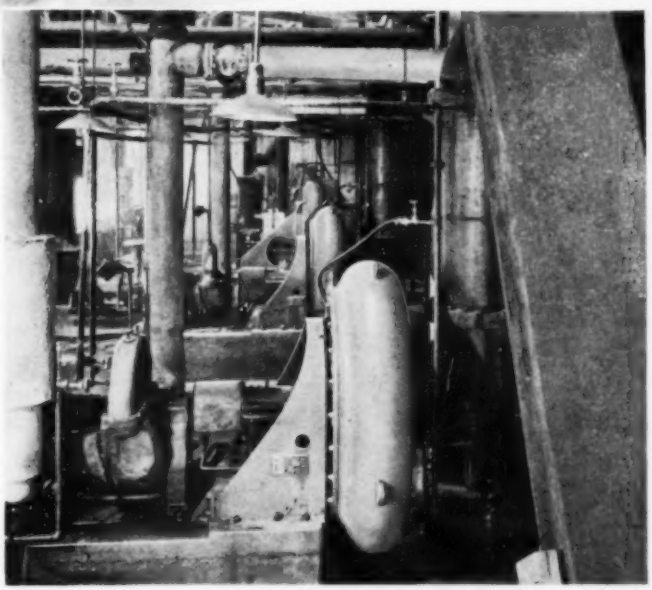
General view of the U. S. Potash Company plant at Carlsbad, N. M.

began serving the U. S. Potash Company of Carlsbad, New Mexico, in 1932, when the first of the present eleven Elliott turbine-driven blowers was installed.

Consider the type of service — round-the-clock operation, 363 days per year, handling air that is saturated with brine resulting from the hot solution leaching process used in separating potassium chloride from the sodium chloride and other impurities with which it is found. After crystallization of the potassium chloride in the solution, it is filtered, during which the Elliott blowers located at the suction end of the filters draw heated air through the filter drums. The possible corrosive action of the brine-laden air is minimized by impellers of special alloy.

It is significant that twenty years of this rigorous service, with only occasional outage for maintenance, has no terrors for Elliott blowers. The original unit is still going strong.

*Elliott engineers will be glad to discuss your blower needs.*



*The line of eleven blowers used in potassium chloride separation. Each blower is rated 12,640 inlet cfm, with an inlet pressure of about 23.0 in. Hg, absolute, discharging to atmosphere (barometer 26.5 in. Hg) and is driven at 3670 rpm by an Elliott steam turbine developing 160 hp.*

**ELLIOTT Company**

**Centrifugal Blower Dept.**
**Jeannette, Pa.**

Plants at JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

**Stainless Steel · Lead · Wood and Steel . . . Custom-Built**
**Equipment for the Chemical and Food Processing Industries**

ACID PLANTS • CHEMICAL PLANTS • PAPER and PULP MILLS • BREWERIES • FOOD PLANTS • DAIRY PLANTS • RAYON PLANTS
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STAINLESS STEEL
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Fabrication

# O. G. KELLEY & CO.

ENGINEERS DESIGNERS FABRICATORS

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CLEVELAND, OHIO • NEW YORK, N.Y. • JOHNSON CITY, TENN. • PITTSBURGH, PA. • HOUSTON, TEXAS • ELIZABETH, N.J.

*Measure Dielectric Constant to* 500 Mc

*Dissipation Factor to* 100 Mc

*with this* NEW GR

# Dielectric Sample Holder



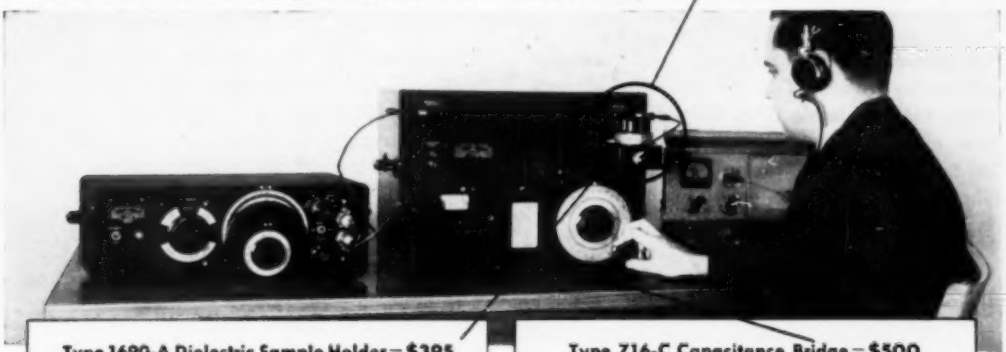
The precise measurement of dielectric constant and dissipation factor over a wide range of frequencies is becoming of increasing importance to users and manufacturers of insulating materials. As the electrical industry makes more use of the higher frequencies, solid materials with increasingly lower losses will be needed. For example, a 2% difference in dielectric constant of a plastic support in coaxial connectors can make the difference between success and failure in the design of units with low voltage-standing-wave ratios.

The new dielectric sample holder is a precision capacitor with a movable top electrode specifically designed for the accurate measurement of solid dielectric properties. This instrument can be used with bridges, susceptance variation circuits and slotted lines to make accurate measurements of dielectric constant and dissipation factor of samples placed between the sample-holder electrodes.

The General Radio Dielectric Sample Holder, used with the Type 716-C Capacitance Bridge, is an ideal combination for precise dielectric measurements at lower frequencies.

The Type 716-C Bridge uses a Schering bridge circuit, widely accepted for measurements of dissipation factor and capacitance; the dielectric constant can be determined readily from knowledge of the capacitance presented by the material in the sample holder.

In making measurements with this bridge and dielectric sample holder, it is merely necessary to balance the bridge with the sample holder and specimen in the unknown arm of the bridge. The sample is then removed and the top plate of the sample holder lowered by turning the micrometer knob until balance is reestablished. The dielectric constant and dissipation factor are readily calculated from the two settings of the sample holder micrometer and the two readings of the dissipation factor dial on the bridge.



**Type 1690-A Dielectric Sample Holder — $395**

*Abridged Specifications*

**RANGE** — *Dissipation factor measurements to 100 Mc; dielectric constant to 500 Mc.*

**SPECIFICATIONS** — *agree with ASTM D-150 Standards.*

**ELECTRODES** — *2 inches in diameter — optically flat surfaces within a few wavelengths.*

**AUTOMATIC DISENGAGING** — *precision-ground micrometer screw drives movable electrode — spring-loaded drive automatically disengages when top electrode seats on sample.*

**MICROMETER VERNIER** — *capacitance readings can be made to within 0.004 μμf; makes possible great accuracy in susceptance variation measurements.*

**Type 716-C Capacitance Bridge — $500**

*Abridged Specifications*

**FREQUENCY RANGE** — *operating frequencies between 30 cycles and 300 kc. (The new Type 716-CS Capacitance Bridge permits measurements from 1 to 3 Mc)*

**ACCURACY** — *dielectric constant measurements can be made within 2%, with the Type 1690 sample holder. Loss measurements on materials with dissipation factors as low as .0002 can be made with an accuracy of ±.00005. Accuracy of measurements of material with higher dissipation factor approaches ±2%.*

**SHIELDING** — *bridge arms, dissipation factor capacitors and shielded transformer are all fully shielded.*

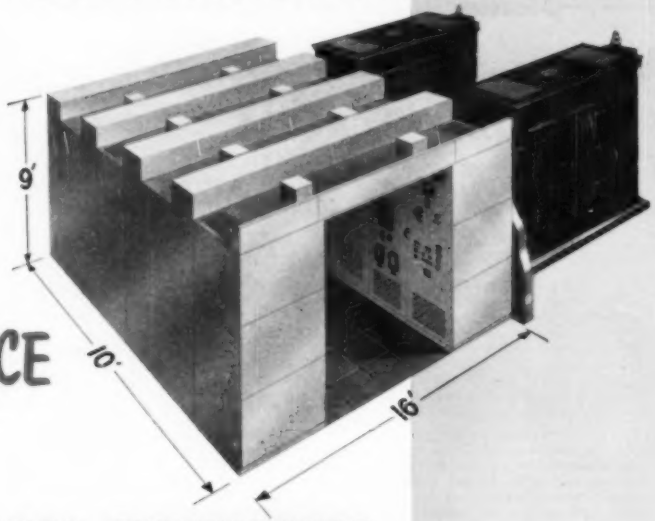
**GENERAL RADIO Company**

275 Massachusetts Avenue, Cambridge 39, Massachusetts

90 West Street NEW YORK 6 — 920 S. Michigan Ave. CHICAGO 5 — 1000 N. Seward St. LOS ANGELES 38

# RECTIFY AC TO DC WITH 96% EFFICIENCY

## ...IN SMALL, COMPACT SPACE




## Install
## I-T-E MECHANICAL RECTIFIERS

On processes requiring a heavy, steady supply of direct current, I-T-E Mechanical Rectifiers yield big dividends. Not only do they give you more d-c for the power you buy (96% efficiency from a-c line to d-c bus) but you also get more power per cubic foot — *high capacity in small space.*

### SAVE SPACE

Simplicity of design plus unified arrangement of steel enclosures assures most economical use of floor space. The 10,000 ampere I-T-E Mechanical Rectifier pictured here requires a *total* floor area of only 160 square feet including operating aisle. A 5,000 ampere installation requires only 120 square feet including aisle. Ceiling need be no higher than 12 feet.

Power transformers are normally located outdoors and throat-connected to the Rectifier cubicle through an outside wall. Overall dimensions vary with KVA and ratio of the transformer. A 1000 KVA transformer nominally occupies 35 square feet.

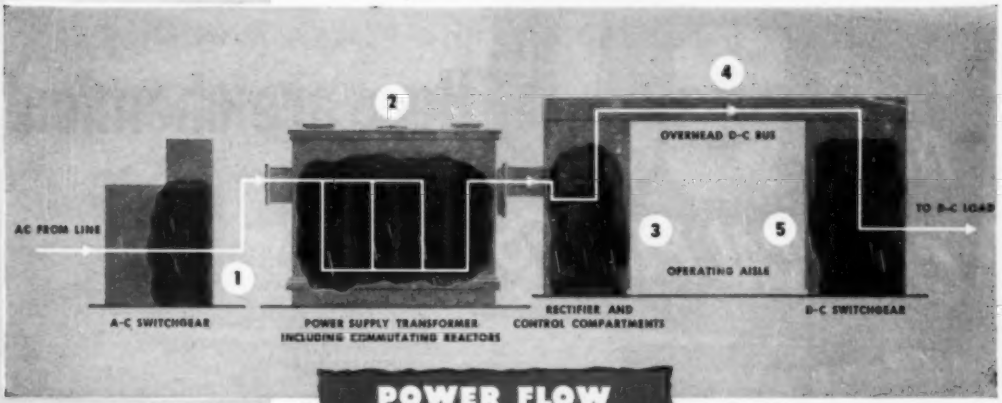
The primary a-c circuit breaker which feeds the transformer forms part of the Rectifier installation, but is ordinarily included in a line-up of HV switchgear at some convenient remote point. A 5 KV circuit breaker, 100,000 KVA interrupting capacity, 1200 amperes continuous rating (draw-out construction), occupies 10 square feet of floor space.

### SAVE ON BUILDING COSTS

The compact Mechanical Rectifier installation is light in weight. It requires no special floors, foundations, or high ceilings—no basement or trenching for buses. The Rectifier stands just 9 feet tall—including *overhead* bus —on an ordinary level floor.

### SAVE ON INSTALLATION COSTS

Factory assembled, wired, and tested, the I-T-E Mechanical Rectifier is delivered as a packaged unit—ready to install. No special equipment or crane facilities are needed. Just unload components, skid enclosures into position, wheel truck-mounted elements into cubicles, connect . . . and the Rectifier is ready to deliver long, dependable service.




**POWER FLOW**
**FROM A-C LINE TO D-C LOAD**

A complete I-T-E Mechanical Rectifier includes: primary a-c circuit breaker, transformer, commutating reactor, contact mechanism, d-c switchgear, and associated instruments and controls.

Incoming alternating current is fed through primary circuit breaker (1) into the combined transformer and commutating reactor (2), to the contact mechanism (3), where it is converted to direct current.

The direct current then travels across the overhead bus (4), through d-c switchgear (5) to feed the load.

## CAPACITY RANGE

Standard ratings for unit installations are: 3000, 4000, 5000, 6000, 7000, 8000, 9000, and 10,000 amperes. Any additional desired capacity may be obtained by paralleling units of suitable ratings.

Output voltage may be any voltage between 50 and 400 volts d-c.

Common primary voltages are: 2300 volts; 4160 volts; 13,800 volts; and 23,000 volts; three-phase, 60-cycle, a-c.

## GET THE COMPLETE STORY

If you're planning new or expanded power conversion facilities, it will pay you to investigate the advantages of I-T-E Mechanical Rectifiers. You get maximum efficiency—in minimum space. You save all along the line.

For complete information, get in touch with your local I-T-E representative without delay. Or, send for illustrated *Bulletin 5106* today.

I-T-E

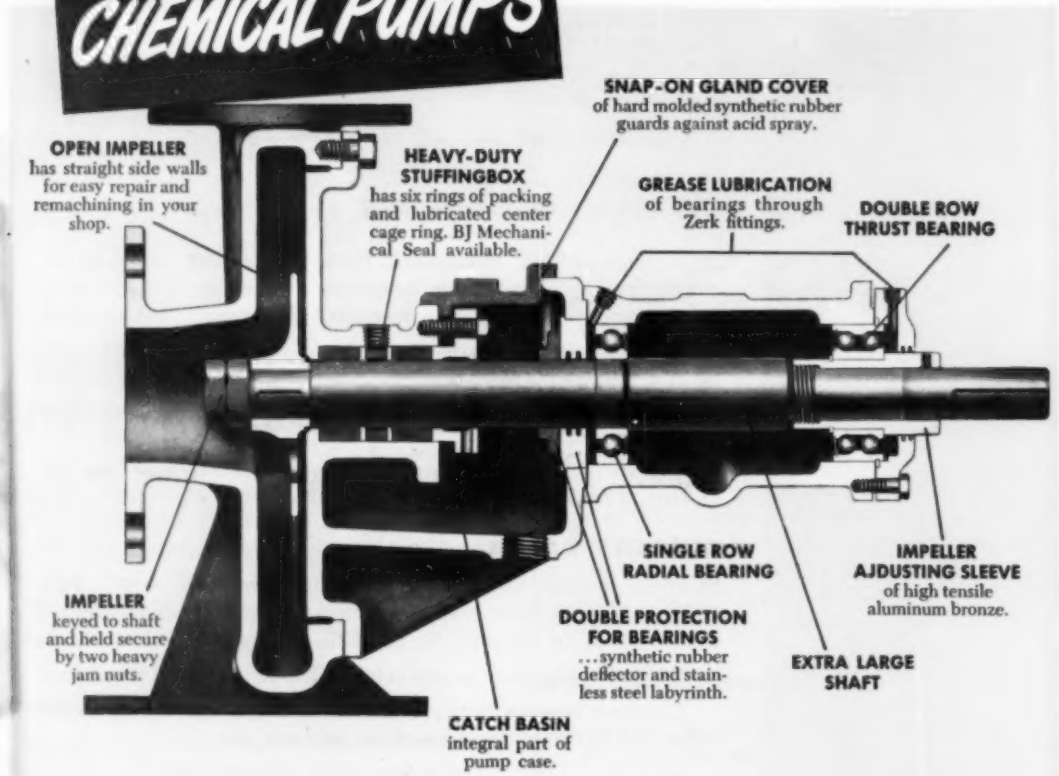
# MECHANICAL RECTIFIERS

**I-T-E CIRCUIT BREAKER COMPANY**
**Rectifier Division**
**19TH AND HAMILTON STREETS, PHILADELPHIA 30, PENNSYLVANIA**

**Canadian Mfg. and Sales: Eastern Power Devices, Ltd., Toronto • Export Sales: Philips Export Corp., N.Y. 17, N.Y.**

# NEW BJ CHEMICAL PUMPS

# Here are chemical



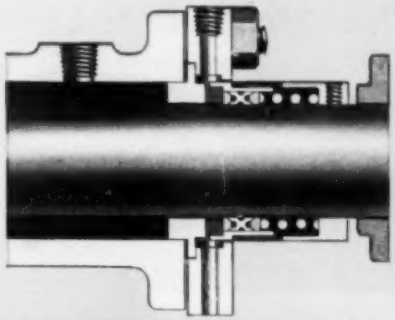

**You've asked for them... now BJ introduces these special construction features!**

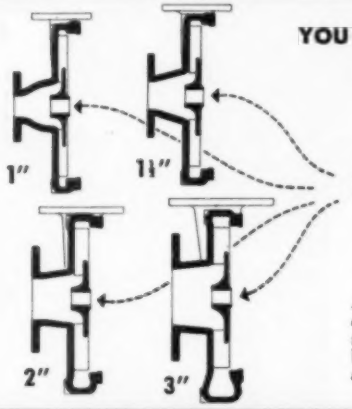
- *Quick and easy dismantling* for inspection and repair without disturbing piping or driver.
- *All parts interchangeable* except pump case and impeller. Four different pump sizes can be used on one basic stuffingbox and bearing bracket assembly.
- *Corrosion-resistant catch basin*—integral part of pump case—guards bearing bracket and base plate from corrosive leakage.
- *Adjusting sleeve* permits compensation for impeller wear—allows easy adjustment without dismantling.
- *Grease lubrication* gives bearings greater protection against acid fumes. Deflector and labyrinth provide double protection against liquid entrance.
- *Cored passages* through impeller web keep stuffingbox under suction pressure.

# pumps engineered to your demands...

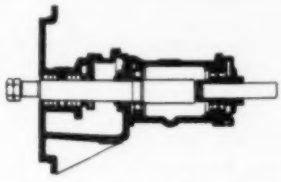
*You—the chemical pump user—dictated the design of these new BJ Chemical Pumps. Before Byron Jackson engineered these new BJ models, chemical pump users were asked what features were wanted most. Now these improved features are yours in the new BJ Chemical Pumps. Four pump sizes are available (1", 1½", 2" and 3") with capacities to 450 gpm and heads to 100 feet.*

**BJ Mechanical Seal also available for protection against leakage.** BJ's Type "A" Mechanical Seal is designed especially for the particular demands of chemical pumping. It replaces the packing and provides positive protection against leakage to the bearings or contamination of the pumped liquid. All major parts of this BJ-designed seal are effectively isolated from contact with pumped liquid. Available as special construction, the BJ Mechanical Seal will save you maintenance time and money by eliminating frequent repacking.






**YOU BENEFIT FROM MAXIMUM INTERCHANGEABILITY OF PARTS!**



All parts except pump case and impeller are *completely* interchangeable. Four different size BJ Chemical Pumps fit one basic assembly! This means that only a few spare parts are needed to service a wide range of pumps.

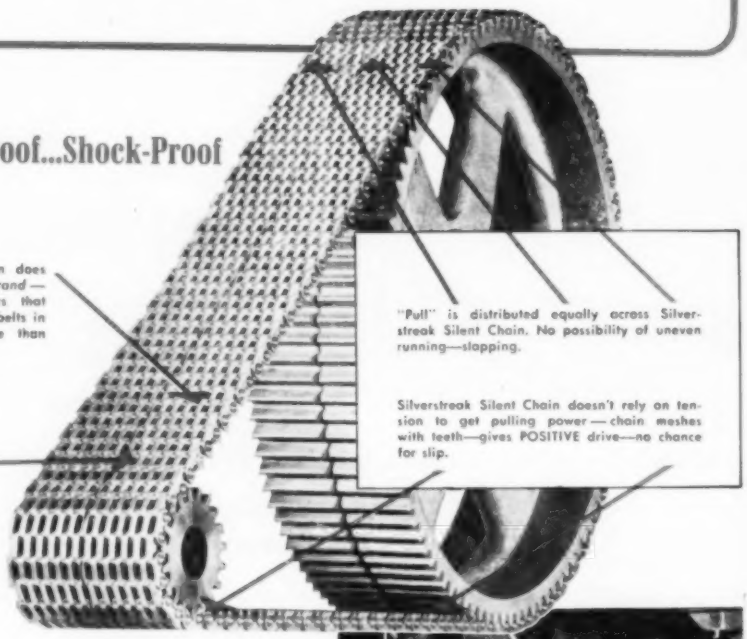
***FOR MORE INFORMATION on these new pumps, write BJ Chemical Pump Dept. 5.***

**BJ makes a complete line of centrifugal pumps to answer your other pumping needs.**

**Byron Jackson Co.**
*Since 1872*
**P. O. Box 2017 Terminal Annex, Los Angeles 54, Calif.**
OFFICES IN PRINCIPAL CITIES

# High-speed, high-hp power transmission is an old story for Silverstreak Silent Chain Drives

## Slip-Proof...Slap-Proof...Shock-Proof




YES, for many years Link-Belt Silverstreak Silent Chain has been the accepted solution for the toughest transmission problems. These time-proven drives stand up under long years of high-speed, high-hp service . . . maintain their efficiency (over 98%) with virtually no attention.

Check the Silverstreak advantages shown here. See for yourself why so many concerns that must combine top transmission efficiency with unfailing dependability—standardize on Link-Belt Silverstreak Silent Chain Drives.

LINK-BELT

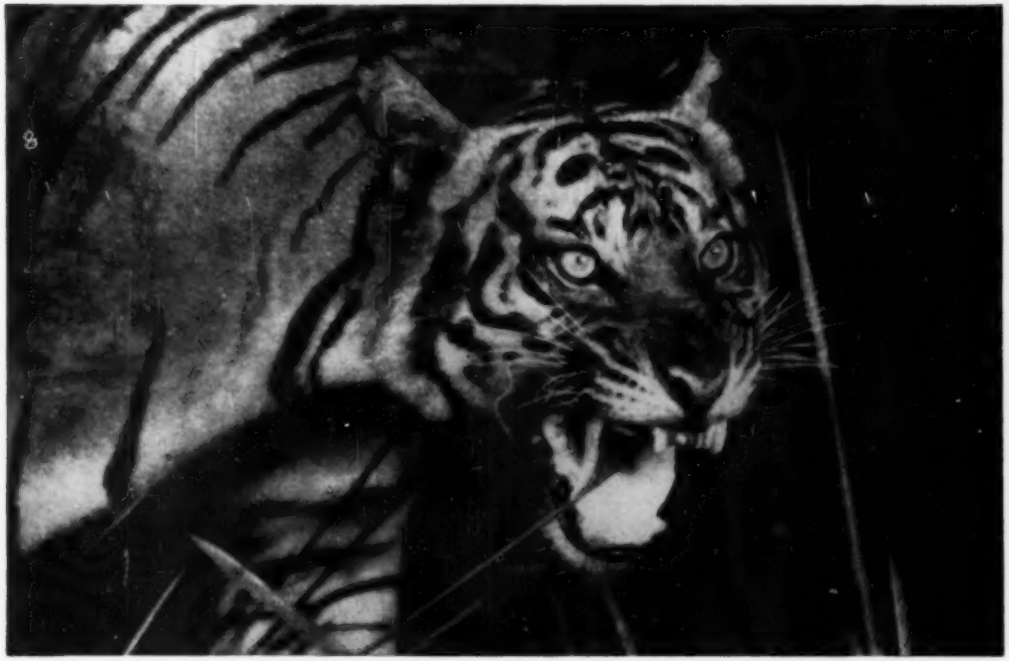
SILVERSTREAK SILENT CHAIN DRIVES



For 12 years, six 100-hp, 4700 f.p.m. individual Link-Belt Silverstreak Silent Chain and two-speed Herringbone Gear Drives at the Miami Daily News have served effectively, maintaining accurate register with minimum maintenance.

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices, Factory Branch Stores and Distributors in Principal Cities. 52,710

You can't stop a tiger with a water pistol



You can't stop corrosion with ordinary paints . . .

# it takes BITUMASTIC COATINGS!

**CORROSION** can't be stopped by ordinary paints or conventional protective coatings. They can't protect surfaces against the ravages of rust for any appreciable length of time.

But Bitumastic Coatings can!

**FIRST**—Unlike maintenance paints, Bitumastic® Protective Coatings are specially formulated from a base* of coal-tar pitch that is, for all practical purposes, impervious to water. When you keep moisture away from an exposed surface, you *stop* corrosion.

**SECOND**—Bitumastic Coatings provide an extra-tough, extra-thick barrier against corrosive elements—a barrier that is impenetrable. These coatings provide up to 8 times the film thickness of conventional paint coatings.

**THIRD**—Bitumastic Coatings stop corrosion caused by moisture—acid fumes—alkaline fumes—corrosive soil—salt air—heat.

*There are 6 Koppers Coatings—formulated to control corrosion of metal and deterioration of concrete. Use the coupon for full information.*

**Hi-Heat Gray contains a metallic base.*

SEND FOR SET OF FREE BOOKLETS!

Koppers Company, Inc., Tar Products Division
Dept. 659-T, Pittsburgh 19, Pa.
Please send me, without charge or obligation, your booklets on corrosion prevention.

Name.....

Address.....

City.....Zone.....State.....

KOPPERS BITUMASTIC PROTECTIVE COATINGS — SOLD THROUGH INDUSTRIAL DISTRIBUTORS

KOPPERS COMPANY, INC., Tar Products Division, Dept. 659-T, Pittsburgh 19, Pa.

DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

# Whether Mine..

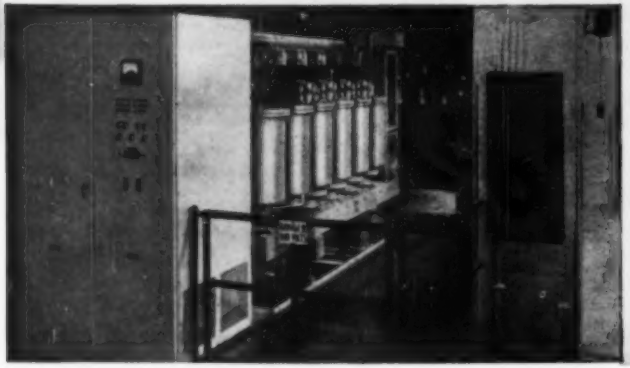
## ALLIS-CHALMERS MERCURY ARC RECTIFIERS WITH EXCLUSIVE DESIGN FEATURES CAN SUPPLY YOUR DC NEEDS



**OUTSIDE** view of one of five Allis-Chalmers rectifier substations serving the haulage system of a coal mining operation. Transmission line enters building at right, dc leaves at left. Entire substation can be moved as coal seams are exhausted, leaving only concrete slab behind.



**INSIDE** is the "dead front," factory packaged, 500 kw, 275 volt dc, sealed tube rectifier. Compartments are (L to R): for rectifier tubes, firing and auxiliary control, dc cathode breaker.



**PUMP** evacuated rectifiers are applied in heavy duty service from 750 kw up. The 3400 kw, 500 volt unit seen here operates in parallel with steam turbine driven dc generators in the electrolytic reduction of metal.

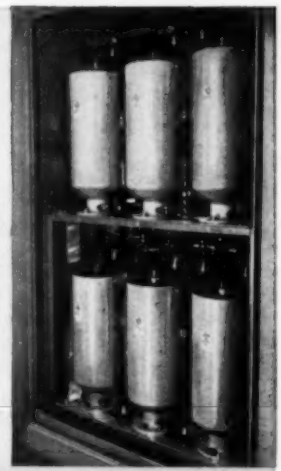
**SIDE** view of pump evacuated rectifier at left, showing the centralized placement of auxiliaries — exclusively Allis-Chalmers. Both evacuation equipment and heat exchanger are accessibly placed at one end.

# ALLIS-CHALMERS

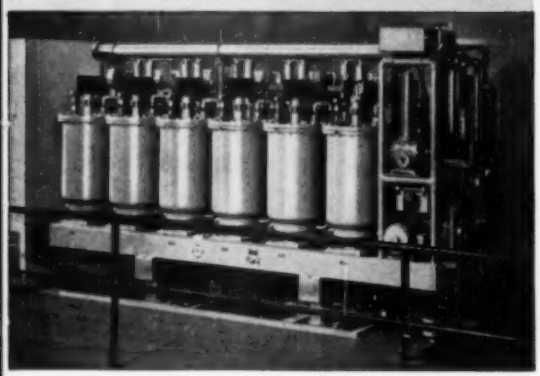
**Allis-Chalmers Engineers Introduced Mercury Arc Rectifiers to U.S. Industry**

# . or Mill!

## ALLIS-CHALMERS MERCURY ARC RECTIFIERS



**MODERN** Allis-Chalmers design sealed tubes are located in the tube compartment. Other sealed tube units are supplied in ratings from 200 to 1000 kw.



WHEREVER DC IS NEEDED, from the mine to the mill, from the Elevated to the elevator, Allis-Chalmers rectifiers are quietly working away.

They combine the high efficiency, low maintenance characteristics of the mercury arc rectifier with exclusive A-C refinements in design and construction.

Factory packaged, light in weight, and requiring no special foundation, they can be placed right at the load center to cut dc feeder losses. Conversion efficiency is higher at all loads with large power savings during light load periods.

And in addition, only from Allis-Chalmers can you get rectifiers with these exclusive design refinements:

### EXCLUSIVE ALLIS-CHALMERS FEATURES

- **Fixed excitation anode** — doesn't contact mercury and is independent of level, turbulence or impurities . . . requiring no adjustment, maintenance or replacement.
- **Continuous excitation** — pilot arc always present, eliminating need for continuous and synchronized re-ignition. Rectifier will ride through severe ac voltage disturbances.
- **Grid phase control** — in cooler and cleaner region near anode, where ion density is lowest.
- **Internal cooling system** — high heat transfer with seamless tube cooling coil located within the rectifier.
- **Arcover-free tank** — eliminates danger of arcing-over to tank by insulating entire arc path.
- **Enamelled anode seals** — multi-layer fused vitreous construction provides high-strength seal, unaffected by thermal variation.

All these design advances are obtainable *only* from Allis-Chalmers. When you consider mercury arc rectifiers in your expansion or modernization planning, consider Allis-Chalmers.

For help with rectifier application and a fuller explanation of exclusive superior features, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3681

*10 Mercury Arc Rectifier Advantages:-*

★ Compact and light weight ★ No special foundation ★ Push button starting with no synchronizing ★ Quiet operation with high power factor ★ Low filling cost and high conversion efficiency ★ High momentary overload capacity ★ Immunity to frequent short circuits ★ No moving parts, contributing to low maintenance cost ★ No attendance needed during operation ★ Resistant to dust, moisture, fumes ★ Simple construction with long life

A-C ALLIS-CHALMERS

# Now...A Complete **NEW LINE** of Protective Clothing... **NEOPRENE LATEX**

**PROTECTIVE CLOTHING**



902 — Suit Jacket and 911 Pants

Here's top quality, "strength without bulk" protection against abrasion, acids, alkalis, greases, oils and salt water! It's the companion line in coats, suits, jackets, pants, hats and hoods to AO's new line of Neoprene Latex aprons. The man who *works* in these garments will appreciate their working ease and comfort — the man who *pays* for them will like their cost-cutting durability! Your nearest AO Safety Products Representative can supply you with this new clothing in yellow or black.

## *QUICK FACTS*

**SATURATION–COATED FOR LONG LIFE**

*Five* applications of 100% neoprene latex thoroughly impregnate and coat the fabric—plus *two* coats on the outside after sewing. You get a garment that won't peel, blister or crack!

**LIGHTWEIGHT — CONTAINS NO LOADERS**

Comfort and lightness result from the absence of "loaders" — materials which make a garment stiffer, heavier, bulkier.

**MORE FLEXIBLE — UNAFFECTED BY HEAT OR COLD**

AO Neoprene Latex remains flexible in extreme cold — does not become sticky in hot weather.

**EASIER TO CLEAN**

Takes laundering, dry cleaning or scrubbing without injury to fabric. Petroleum solvent may be used.

**WORK-STYLED FOR GOOD FIT**

All garments are generously cut for free action. Inter-locked seams. Extra heavy stitching. Fasteners securely anchored.



901 — ¾ Length Coat



913 Pants and 922 Hat



9011 One Piece Suit and 921 Hood

American Optical Company
SAFETY PRODUCTS DIVISION

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

*AO's Industrial Vision Program increases production, decreases accidents. Write today for free booklet "Improved Industrial Vision."*



# Plant Protection, A MILLION TIMES OVER

More than five million Nordstrom valves have been installed in gas, petroleum, chemical and other industrial flow lines. Each one is a little additional insurance, an extra unit of plant protection.
The record is their best reference.

**Rockwell** | **Built**
Another Rockwell Product | **Nordstrom Valves**
LUBRICANT SEALED TO KEEP UPKEEP DOWN



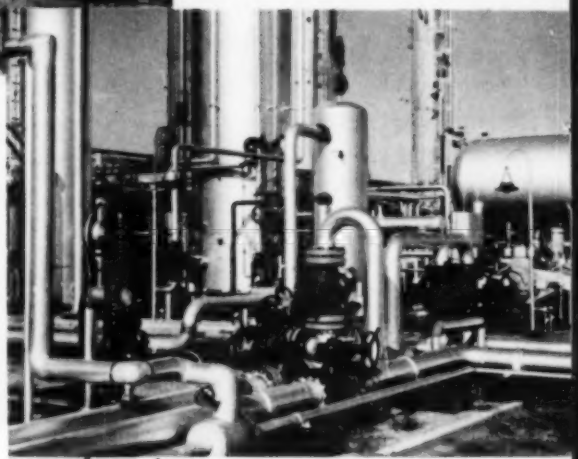
# You'll Find Nordstrom Valves ANYWHERE . . . *Everywhere*

**FIELD SERVICES**

New design Christmas tree in Louisiana oil fields, built with Nordstrom 5,000 lb Hypreseal valves, is typical of Nordstrom field applications. This dual completion tree stands on well, producing from two depths.

**PROCESS LINES**

In a single process plant you'll likely find a dozen different types of Nordstrom valves. There is a proper Nordstrom valve for nearly any process service. Nordstrom valves in lines shown here are teamed with Rockwell-built Edward forged steel valves.



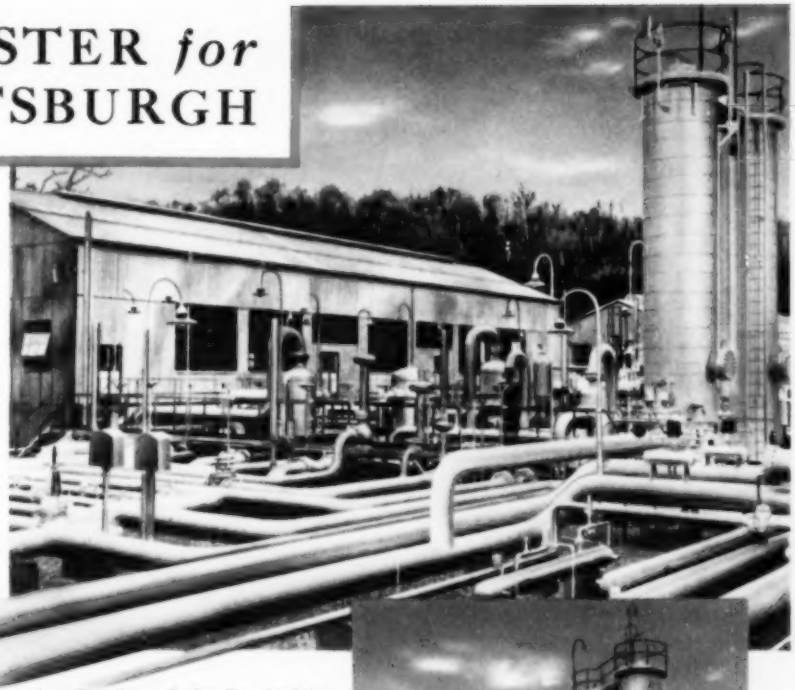
**Rockwell** | **Built**
Another Product
**Nordstrom Valves**

LUBRICANT SEALED TO KEEP UPKEEP DOWN

*Anywhere . . . .* **EVERYWHERE**

In gas, petroleum, chemical and general industrial service . . . there's a Nordstrom Valve to do the job.
Rockwell Manufacturing Company,
400 N. Lexington Ave., Pittsburgh 8, Pa.

# BOOSTER *for* PITTSBURGH



**The Pratt Compressing Station of the Equitable Gas Company will increase the flow of natural gas to the Pittsburgh area during periods of high demand.**

Pressure is boosted; gas from a local field is compressed and delivered to the system; and gas compressed and stored underground during low periods is released as needed.

Stone & Webster Engineering Corporation was retained for the design, and supervision of construction of the Pratt Station.



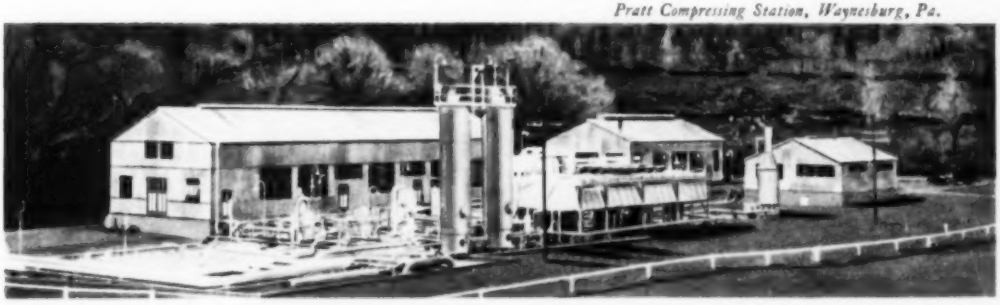
*This project, consisting of compressing station and a dehydration unit, has a capacity of 52 million standard cubic feet per day.*

## STONE & WEBSTER ENGINEERING CORPORATION

### BADGER PROCESS DIVISION

AFFILIATED WITH E. B. BADGER & SONS (GREAT BRITAIN) LTD.

*Pratt Compressing Station, Waynesburg, Pa.*



# BETHLEHEM AT BEAUMONT
# Serves the Oil and Gas Industry




The photograph above shows only a section of Bethlehem's Beaumont Yard, but it indicates graphically why this combination shipbuilding and ship repairing unit is regarded as one of the most progressive in the nation.

Here, in this view, are six different types of craft. Three of these types, the drill barge, gas compressor barge and tank battery barge, were developed by the Beaumont Yard to make possible more efficient exploitation of off shore oil and gas fields. The three Beaumont built oil barges were designed to provide economical transportation of petroleum and its products. The Liberty ship and naval craft in the background are undergoing repairs. Not shown are the yard's excellent facilities, including a 15,000 ton dry dock, for repairing tankers and other commercial and naval vessels.

Yes, this photograph tells a story . . . the story of how Bethlehem's Beaumont Yard serves the oil and gas industry.

*Trade-Mark of Dependability*




**SHIP REPAIR YARDS**

| | |
|---|---|
| Boston Harbor | New York Harbor |
| Baltimore Harbor | Beaumont, Texas |
| Los Angeles Harbor | San Francisco Harbor |

**SHIPBUILDING YARDS**

| | |
|---|---|
| Quincy, Mass. | Staten Island, N. Y. |
| Sparrows Point, Md. | Beaumont, Texas |
| Terminal Island, Calif. | San Francisco, Calif. |

***SHIPBUILDERS*** ***SHIP REPAIRERS***

**BETHLEHEM STEEL COMPANY**

*Shipbuilding Division*

General Offices: 25 Broadway, New York 4, N. Y.

On the Pacific Coast shipbuilding and ship repairing are performed by the Shipbuilding Division of Bethlehem Pacific Coast Steel Corporation

## the design that's going places



***FATTY ACID DISTILLATION***

These stills have been fabricated along with other process components at the Carteret, N. J. shops of Foster Wheeler for export to Montevideo, Uruguay and Santos, Brazil where plants for the distillation of fatty acids are being erected by the company.

Both plants are based on a design which proved highly effective in connection with other Foster Wheeler installations now producing upwards of 150,000,000 pounds of fatty acids per year.

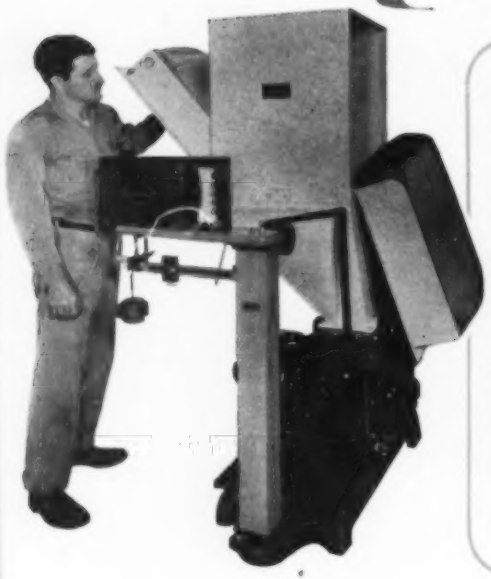
Foster Wheeler, with its complete engineering and construction services, is uniquely equipped to provide the overall responsibility for far-flung projects of this nature.

**FOSTER WHEELER CORPORATION**
**165 BROADWAY, NEW YORK 6, N. Y.**

**FOSTER WHEELER**

**FEED DRY ADDITIVES AT LOW RATES . . .**

*Continuously— Accurately— Automatically!*



### ADVANTAGES

**Integral hopper** holds two bags or an entire 125 lb. drum of dry material. When required, feeder can be furnished with 5 cu. ft. round hopper.

**Low filling height** of approximately 36 in.

**Dust-free filling** saves valuable materials . . . simplifies plant housekeeping.

**Accurate measurement** with large feeding orifice which prevents stoppage by small lumps.

**Automatically lubricated driving mechanism.**

**Percentage adjustment** with rate of feed scale graduated 0 to 100.

**Uniform rate of feed** controlled by variable speed drive.

**Positive hopper agitator** prevents packing of material in hopper.

**Dosage check** by means of weighing scales.

Modern processing systems demand the extremely accurate feeding of dry additives provided by Omega Disc Feeders. Now, even the feeding of a few ounces to a few pounds of dry material per hour can be as closely regulated as the rest of your automatic processing systems.

This is a complete "packaged" system. Install it; load it; set it; and forget it. Like other Omega feeding and blending systems, Omega Disc Feeders are designed to eliminate costly manual operations and to save money and improve process control by providing greater accuracy of dry material feed.

The Model 51 Omega Disc Feeder has a maximum feeding capacity of 10 cu. ft. per hr. Write us about your continuous processing and blending problems. We will gladly show you how the various models of Omega Disc Feeders and other equipment can be adapted to your own particular needs. Omega Machine Company (Division of Builders Iron Foundry), 369 Harris Ave., Providence 1, Rhode Island.

B-I-F INDUSTRIES

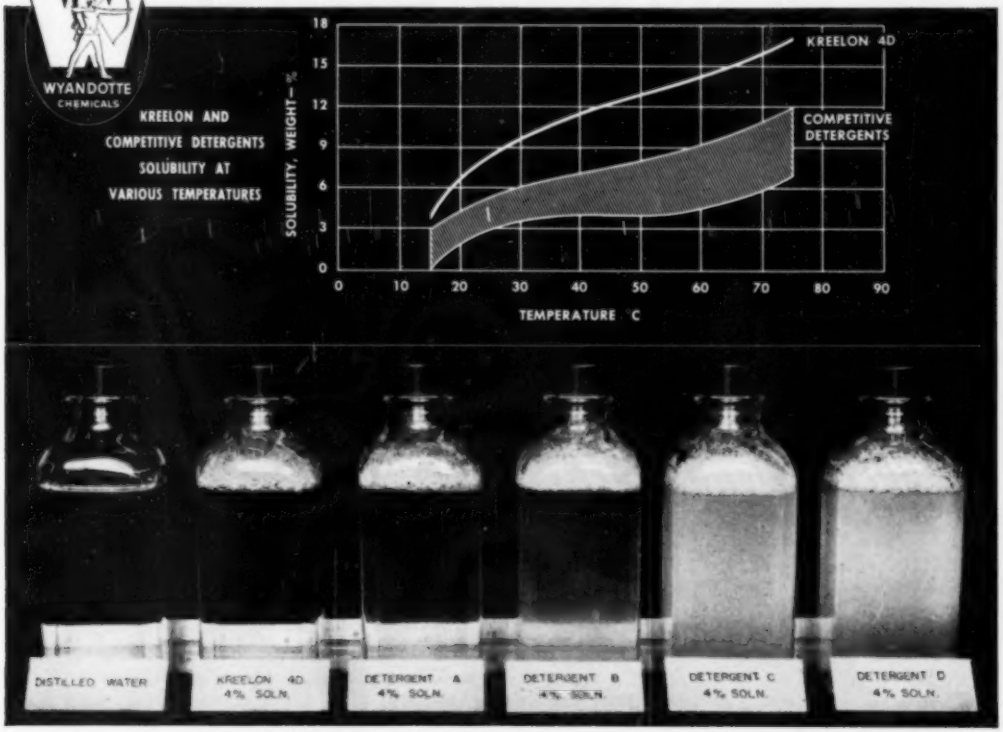
**OMEGA**

THE LAST WORD IN FEEDERS

OMEGA

*Omega manufactures a complete line of volumetric and gravimetric feeders for dry materials and for gravity feeding of liquids and solutions.*

## Dependable Source for Chemical Raw Materials




# Tests give two-way proof of Wyandotte ... KREELON solubility:

**BULLETIN BOARD**

***Dicol*®:**
This mixture of diglycols, predominantly diethylene glycol, has shown outstanding efficiency in plasticizing and humectant applications . . . plus up to 20% savings! Write for samples, data.

***Soda Ash, Caustic:***
Supply of these basic chemicals is adequate for the present; and we're increasing production to meet the expanding needs of industry.

***Purecal:***
Recent advances in GR-S compounding and processing, using this whitest pigment extender known (Wyandotte's precipitated calcium carbonate), warrant cost comparison with cheapest natural-rubber formulas. Other profitable applications: paint, paper, ink manufacture.

In this solubility-comparison test (bottles, above) using a 4% solution of KREELON and competitive detergents (25°C.), KREELON's superior solubility is outstanding. Observe KREELON's freedom from insoluble impurities. As much as 25% of some competitive detergents is lost as insoluble material. KREELON delivers full effectiveness!

And a look at the graph shows the amazing solubility of KREELON* through the indicated temperature range. At 75°C., it is soluble to the extent of 17% by weight . . . permits concentrated stock solutions!

***Many applications***

In industrial, maintenance, laundry, or household cleaners, and in the paper or textile industry, this high solubility of WYANDOTTE KREELON is advantageous. It goes to work immediately, giving you better cleaning and faster, more effective wetting at less cost.

Newly improved KREELON has other benefits, too. Send for 24-page KREELON booklet! And for data on other Wyandotte chemicals, or samples, write — *Wyandotte Chemicals Corporation, Wyandotte, Michigan. Offices in Principal Cities.*

*REG. U.S. PAT. OFF.

Wyandotte CHEMICALS



# SPEED ADVANCEMENT

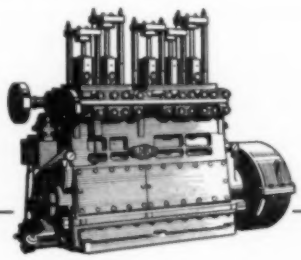
## Aldrich did it with Direct Flow Pumps

Not too long ago, 150 rpm was considered high speed operation for reciprocating pumps. But today—as a result of improved design and stronger metals—Aldrich Direct Flow Pumps are operating efficiently at *or over* speeds of 500 rpm for the 3″, 360 rpm for the 5″, and 300 rpm for the 6″ stroke unit. This increase in speed means simply this:

You get more work—greater pressure and volume—out of a smaller pump. You invest in a lighter, lower cost unit . . . a pump with a *sectionalized* fluid-end that's extremely easy to maintain and which can be made of stainless steel, bronze, Monel or other special material, as desired.

*Applications* include handling of caustic solutions, fatty acids, nitric acid, acetic acid, aqua ammonia, anhydrous ammonia, also liquids encountered in petroleum refining, petro-chemical and other industries.

Request Data Sheets on 3″, 5″, or 6″ Stroke Pumps for complete information.



THE ALDRICH PUMP COMPANY

3 GORDON STREET • ALLENTOWN, PENNSYLVANIA

*...Originators of the Direct Flow Pump*

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Detroit Duluth • Houston • Jacksonville • Los Angeles • New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore. Richmond, Va. • St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa.

# STURTEVANT ROTARY FINE CRUSHERS

## Crush or Granulate to Fine, Even Sizes without Excess Dust...



Cross section view illustrating the crushing action

These rugged crushers speed output of fines, cut reduction costs. Desired fineness is quickly obtained by regulating hand wheel. "Open-door" accessibility permits fast, easy cleaning. They crush fine . . . crush fast and do not clog. Available in output capacities from 1 to 30 tons-per-hour. Write for catalog.

**STURTEVANT MILL COMPANY**
100-A CLAYTON STREET, BOSTON 22, MASSACHUSETTS

*Designers and Manufacturers of:* CRUSHERS • GRINDERS • SEPARATORS • CONVEYORS
MECHANICAL DENS and EXCAVATORS • ELEVATORS • MIXERS

**CLIP AND MAIL COUPON TODAY**

Sturtevant Mill Company
100-A Clayton Street
Boston 22, Massachusetts

Gentlemen:
Please send me catalog describing your Rotary Fine Crushers. I am interested in crushing _____

*Name* _____

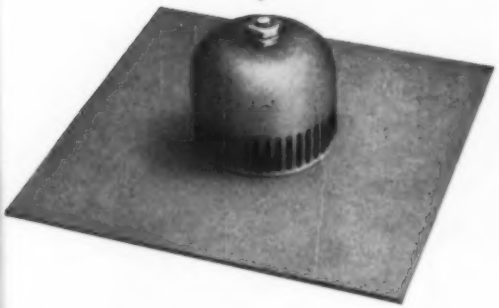
*Street* _____

*City & State* _____

*Firm* _____

# "MANY TIMES LONGER LIFE FOR EQUIPMENT ON $H_2SO_4$ JOBS"

## *report users of* Carpenter STAINLESS NO. 20 . . .



Fractionating tower parts can stay on the job longer *without replacement* when they are made from Carpenter Stainless No. 20.



Immersion heating unit with a sheath of Carpenter Stainless Tubing No. 20 stands up under almost continuous attack by *sulphuric, nitric, formic and other acids.*

In sulphonation or other processes which cause the formation of sulphuric, formic, acetic and other highly corrosive agents, Carpenter Stainless No. 20 is increasing equipment life from two to twenty times.

Where an essential process must keep going, with minimum interruption for equipment maintenance or replacement, this relatively new wrought Stainless Steel may be your answer.

Similar in analysis to "Durimet 20", Carpenter Stainless No. 20 is produced in the forms of tubing, pipe, sheet and plate. Bar stock, wire and strip are produced by the Carpenter mill at Reading, Pa.




**New 16-Page Book of Technical Data**

For complete information on No. 20 and the jobs it can do, write us a note on your company letterhead and ask for the new Carpenter Stainless No. 20 book. If you now have a typewritten bulletin about No. 20, replace it with this new book.

**THE CARPENTER STEEL CO.**
**Alloy Tube Division • Union, N. J.**

Export Department: The Carpenter Steel Co.
Reading, Pa.—"CARSTEELCO"

*Carpenter*

**STAINLESS NO. 20**

Licensed under patents of The Duriron Co., Inc.

# A.O.Smith Multi-Layer Heat Exchangers

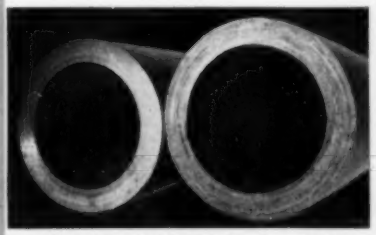
## Meet the Challenge of High Pressure Specifications



**MULTI-LAYER** Heat Exchanger for an ammonia plant. The shell, designed for 5150 psi working pressure, is 23 inches and 13¾ inches in diameter with wall thickness of 4¼ inches and 3 inches, respectively.



Heat Exchanger tube bundle for the above is designed to take advantage of low differential operating conditions within an exchanger designed for 5150 psi chemical process.



**MULTI-LAYER** shell courses showing wall of concentric layers of steel plate. End at right has wrapping completed; at left, machined and scarfed for welding to next course or closure.

**Remarkable flexibility** of design and manufacture makes A. O. Smith MULTI-LAYER Heat Exchangers adaptable to a wide range of high-pressure services.

**MULTI-LAYER** Heat Exchanger shells are built up from concentric layers of relatively thin steel plate progressively wrapped, tightened and welded together around an inner pressure-tight cylinder.

**Wrapping tension** and weld shrinkage develop desirable compression in the inner layers of the shell during manufacture. This results in more equalized loading of all portions of the heat exchanger wall under working pressure. Thus, the full calculated strength of the steel is more completely utilized.

**End closures** to suit any operating condition are designed by engineers who draw on accumulated A. O. Smith experience in manufacturing more than 6,000 MULTI-LAYER vessels of various types and for pressures up to 10,000 p.s.i.

**Where corrosion** is a problem, only the inner shell need be made of corrosion-resistant materials. The load-bearing portion of the vessel wall—since it is not in contact with corrodents—can be manufactured of more economical and readily weldable steel plate.

**This feature,** alone, frequently effects substantial savings over the cost of solid alloy construction and is especially advantageous during the current restrictions on use of certain alloy materials.

**Call upon A. O. Smith** for assistance on your heat exchanger problems. Write the nearest office or use the handy coupon.

**A.O.Smith**

VESSELS • HEAT EXCHANGERS

**Chicago 4 • Cleveland 15 • Dallas 2 • Denver 2 • Houston 2 • Los Angeles 22**
**Midland 3, Texas • New Orleans 12 • New York 17 • Pittsburgh 19**
**San Francisco 4 • Seattle 1 • Tulsa 3 • Washington 6, D.C.**
**International Division: Box 2023, Milwaukee 1**

**A. O. Smith Corporation**
**Dept. CE-652, Milwaukee 1, Wis.**

Without obligation, send me bulletins and information on your MULTI-LAYER Heat Exchangers and their construction features.

Name_____

Address_____

Firm_____

City_____

**Industries served by VU Boilers**

Aircraft
Asphalt
Automobile
Breweries
Building Materials
Carpet
Cellophane
Cement
Chemical
Coal Mining
Coke
Cold Storage
Dairy
Department Stores
Distilling
Explosives
Electrical Equipment
Electric Power
Food Products
Foundries
Gas Works
Gelatine
Glass
Hosiery
Knitting Mills
Institutions
Laundries
Leather
Linoleum
Locomotive
Lumber
Machinery
Metal Producing
Mining
Municipal
Oil Refining
Paint
Paper
Public Utilities
Radio
Railways
Refrigeration
Rubber
Schools
Sewage Plants
Shipbuilding
Sugar
Textile
Tobacco
U. S. Government

# Industries follow

In industry after industry, you'll find leading companies are setting the pace for efficient, reliable steam production with C-E Vertical-Unit Boilers.

The Chemical Industry is a typical example. For VU Boilers have been purchased by most of the major manufacturers in this industry, including such nationally-known leaders as those shown in the list below.

Furthermore, chemical manufacturers, both large and small, have *proved* their satisfaction with Vertical-Unit Boilers by buying them again and again. In 1951, for example, more than 60 per cent of the VU capacity ordered by chemical companies represented repeat order business. One leading manufacturer, in fact, has purchased twenty-seven units during the past twelve years – *eleven of them in 1951!*

You can profit from the experience of the Chemical Industry – as from any industry where steam for power or process is of major importance. If you use steam, investigate the lower steam costs you can get through the advanced design . . . sound construction . . . proved reliability of VU Boilers. They are available in capacities to fit your needs–from 10,000 to 350,000 pounds of steam per hour.

## Typical List of Chemical Companies that have purchased VU Boilers for one or more plants

Air Reduction Co., Inc.
Allied Chemical & Dye Corp.
Atlas Powder Co.
Carbide & Carbon Chemical Corp.
Colgate-Palmolive-Peet Co.
Diamond Alkali Co.
E. I. du Pont de Nemours & Co., Inc.
B. F. Goodrich Chemical Co.
Hercules Powder Co.
Merck & Co., Inc.
National Distillers Chemical Co.
Pennsylvania Salt Mfg. Co.
Pittsburgh Coke & Chemical Co.
Charles Pfizer & Co.
Shell Chemical Co.
U. S. Industrial Chemicals Co.

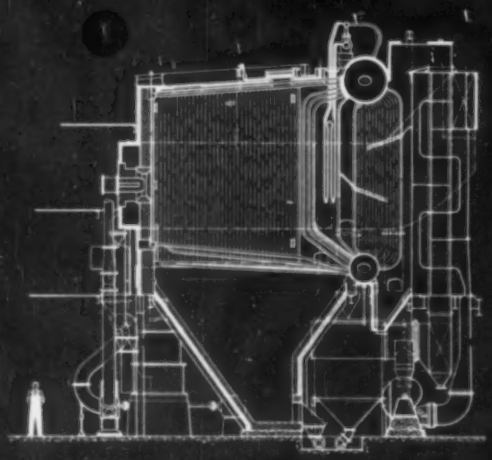
C-E

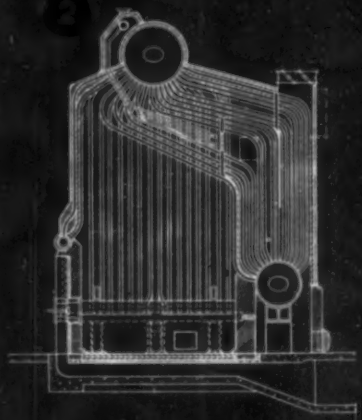
**COMBUSTION ENGINEERING–SUPERHEATER, INC.**

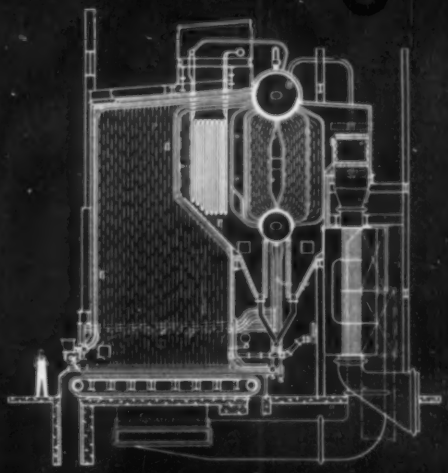
200 Madison Avenue • New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL

# the Leaders to VU







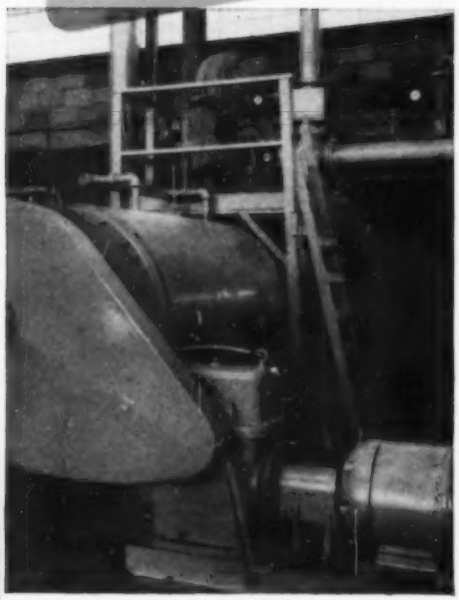
**1 VU-50 BOILER** installed in Midwestern plant. This boiler is fired with pulverized coal using C-E Raymond Bowl Mills. The capacity is 65,000 lb of steam per hr. Steam pressure is 400 psi — steam temperature is 600 F.

**2 VU-10 BOILER** fired with oil. Installed in an Eastern plant, the boiler's capacity is 15,000 lb of steam per hr at 250 psi and 480 F. VU-10 capacities range from 10,000 to 60,000 lb of steam per hr. They may also be fired by spreader, underfeed or chain grate stokers.

**3 VU-40 BOILER** installed in a large Southern plant. This unit is fired by coal, using C-E Spreader Stokers (continuous discharge type). Capacity of this boiler is 150,000 lb of steam per hr at a pressure of 900 psi and a temperature of 808 F.

SYSTEMS AND STOKERS, ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

# VACUUM DRYING reduces water content to 0.1%



Stokes Rotary Vacuum Dryer at Hooker Electrochemical Co., Niagara Falls, N. Y.

Only by processing under vacuum at low temperature can heat-sensitive materials be dried without destroying all or part of their desired properties.

Hooker Electrochemical Company, Niagara Falls, N.Y., makes a highly heat-sensitive chemical product, first produced in a semi-liquid state with 35% moisture content. The material is uniformly dried in large batches of three or four tons to 0.1% in Stokes Rotary Vacuum Dryers. Vacuum of 1½" Hg. Abs. is maintained from 8 to 12 hours. Weight of the material is reduced from 62 to 52 pounds per cubic foot. Properties of the material remain unchanged.

Fast, thorough, economical drying of many products in large batches, with a minimum of labor, is characteristic of rotary vacuum drying. Water or other solvents are dried from wetted solids at temperatures as low as 100° F. Solvents are recovered at 99%, or better, which often pays for the equipment in as little as six months.

Stokes is the only manufacturer of complete vacuum processing systems. Stokes Advisory Service and testing facilities are available on a confidential basis to help manufacturers plan for profitable production by Vacuum Drying or other vacuum processing operations.




• Send for a copy of this new 24-page brochure, "Vacuum Drying", which describes the uses of vacuum drying and the wide range of processes and equipment by which materials are dried under vacuum.

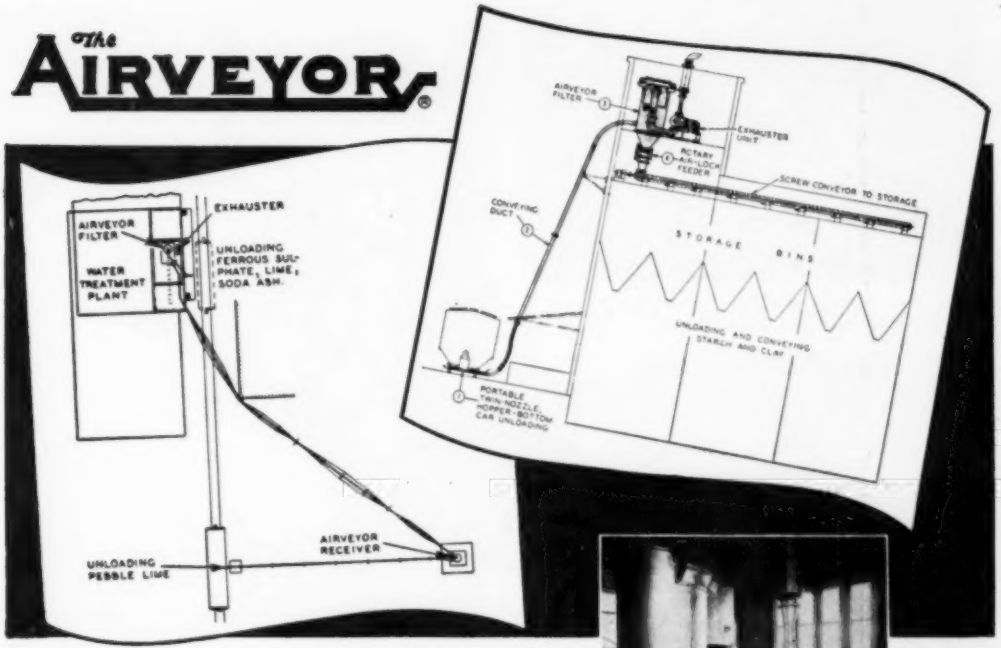
**STOKES**

**STOKES MAKES**

Plastics Molding Presses,
Industrial Tabletting
and Powder Metal Presses,
Pharmaceutical Equipment,
Vacuum Processing Equipment,
High Vacuum Pumps and Gages,
Special Machinery

**F. J. STOKES MACHINE COMPANY, 5530 TABOR ROAD, PHILADELPHIA 20, PA.**

# The AIRVEYOR®








## Pre-planning means a more efficient installation

## . . . always START FROM SCRATCH

When you handle dry pulverized and granular materials, the sensible, economical, and most satisfactory plan of selecting a pneumatic conveying system is to "Start from scratch" . . . make your selection while the plant is still in the planning stage. Pneumatic conveyors permit economy and convenience in location of buildings and production equipment without the restrictions or straight-line limitations of mechanical conveyors.

Fuller Engineers have years of experience in their field. They'll survey your plans, make a close study of local conditions and the materials to be handled. Then—they'll make their recommendation from one of the four Fuller time-and service-proved systems, at no obligation to you.

And—because each installation has peculiar requirements of its own—their recommendation will be the right one for the job—the system that will handle your materials in the most efficient and economical way. Shown here is the Airveyor, used successfully for unloading dry pulverized, crushed, granular materials from shipping units, and for conveying to and from storage. It is economical, safe, thoroughly dependable.

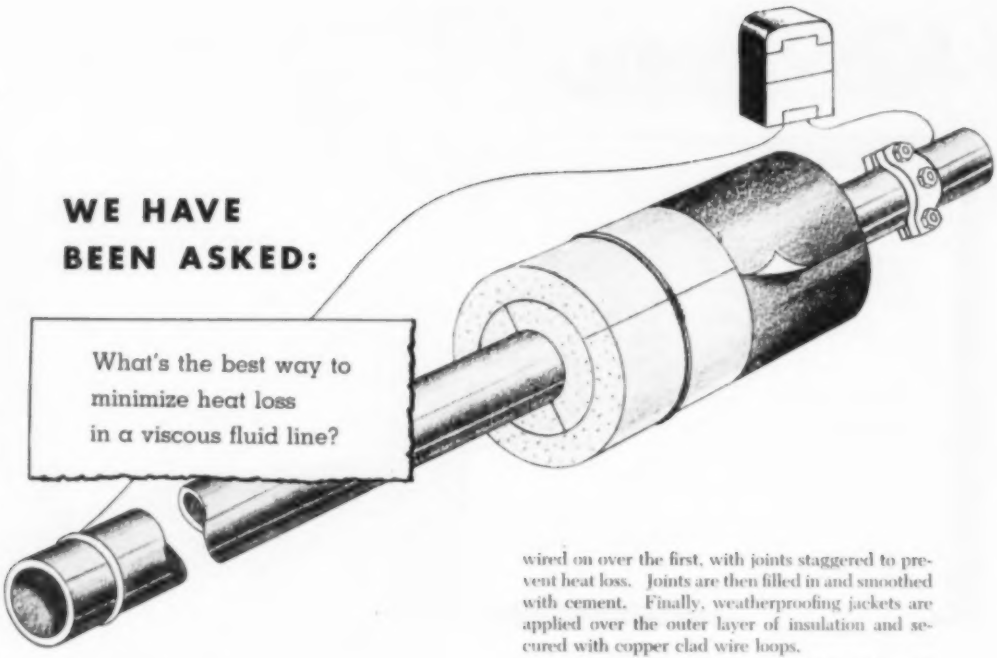
Fuller has specialized in pneumatic conveying systems and knows from experience that the most successful, the most economical, and the most trouble-free installations are engineered and built along with the plant, with individual requirements in mind. Call on Fuller when planning a new plant or modernizing an old one; you'll be sure of a conveying system that meets your requirements in every detail.

FULLER COMPANY, Catasauqua, Pa.
Chicago 3—120 So. LaSalle St.
San Francisco 4—420 Chancery Bldg.

**Fuller**

DRY MATERIAL CONVEYING SYSTEMS AND COOLERS — COMPRESSORS AND VACUUM PUMPS — FEEDERS, AND ASSOCIATED EQUIPMENT

A-120



## WE HAVE BEEN ASKED:

What's the best way to minimize heat loss in a viscous fluid line?

We recently received a letter which posed this problem:—"How should we insulate a 3" outdoor pipe line which carries asphalt approximately one thousand feet from a storage tank to the processing operation? The asphalt leaves the heated tank in a fluid state at 450° F. and must be kept above 435° F. to insure proper flow."

With this great length of pipe, insulation alone cannot be expected to hold the temperature above the 435° minimum. Should occasional shutdowns occur, no practical amount of insulation will prevent the asphalt from solidifying in the line, particularly in cold weather. Some method of applying heat to the pipe such as charging it with low voltage electricity or using a steam tracer line is recommended. This will keep the pipe warm enough to maintain proper temperature and keep the asphalt fluid, regardless of interruptions in the flow. The line should then be insulated with Double Standard 85% Magnesia according to standard specifications.

The pipe covering is applied in two layers, the first being securely wired in place. The second layer is wired on over the first, with joints staggered to prevent heat loss. Joints are then filled in and smoothed with cement. Finally, weatherproofing jackets are applied over the outer layer of insulation and secured with copper clad wire loops.

85% Magnesia is ideally suited to this and a variety of other jobs for temperatures up to 600° F. It has proved its outstanding insulation efficiency and durability through years of trouble-free service. It offers great mechanical strength, will give top performance even under severe conditions. Yet it is lightweight, easy to apply, and completely fireproof.

Next time you're up against any insulation problem, contact your near-by Armstrong office. The technical advice of an Armstrong engineer is always available to you with no obligation. The Armstrong organization can take over the entire job for you—furnish the correct materials for your particular job and the skilled workmen to apply them properly. Our complete insulation service can save you time, trouble, and money—and you'll be **sure** of having a thoroughly professional job!

**SEND US YOUR QUESTIONS.** If you have any question on insulating materials or their use in high-temperature installations, please write us. We'll see that you get a prompt, practical answer. Just address your letter or post card to Armstrong Cork Company, 3306 Maple Avenue, Lancaster, Pennsylvania.

# ARMSTRONG'S INDUSTRIAL INSULATIONS

**MATERIALS - INSTALLATION**

**FOR ALL TEMPERATURES FROM 300°F. BELOW ZERO TO 2800°F.**



Allis-Chalmers multi-stage blower with 5100 rpm steam turbine drive supplies 8000 cfm at 7 psig.




Driven at 3600 rpm by Allis-Chalmers motors, two single stage blowers in series supply 7200 cfm at 7 psig.

# Speed Yeast Production

IN MODERN YEAST PRODUCTION, centrifugal blowers supply air for agitation during the growing process. Seen here are two different Allis-Chalmers blower installations for yeast agitation, both at one of the Milwaukee plants of The Red Star Yeast & Products Co.

While performing essentially the same duty, each servicing several large yeast vats simultaneously, the installations represent different solutions to the same application problem.

The steam turbine driven multi-stage blower (upper right) utilizes low pressure steam exhausted from reciprocating engines...energy that might otherwise *be wasted* if the steam were sent directly to condensers! Output is adjusted by variable speed control.

Connecting the two single stage blowers in series (above) is an economical method of meeting the demand with induction motor drives. A multi-stage blower here would require gearing. Output control is by means of streamlined pre-rotation vanes at the first impeller inlet, giving efficient variable blower performance at constant drive speed.

When *you* have an application problem concerning air and gas handling equipment, consult Allis-Chalmers! Whether your process calls for agitation, aeration, circulation, or combustion, A-C will meet your *particular* need from its complete range of equipment. *Five separate types* of blowers and compressors are built in a wide size and material range.

Allis-Chalmers assumes responsibility for the operation of a complete installation, supplying electric or turbine drives and automatic flow or pressure control. For detailed information, call your nearest A-C sales office or write to Allis-Chalmers, Milwaukee 1, Wis.

A-3481

**ALLIS-CHALMERS**



# how to chelate

(pronounced "Key-late")

## .... Versene*

### VERSENE* CHELATES CATIONS

Before you can chelate foreign metallic ions in solutions you must have a powerful chelating agent such as Versene. This is a compound that will inactivate cations with the formation of inner ring structures in the molecule. It makes the metallic ion become part of the rings. This is a valuable thing to know because it will prevent all kinds of contamination caused by cations.

### PREFERENTIAL CHELATION

When Versene is added to a mixture of various metallic ions chelation will be preferential. That is, one metal will be complexed before another. When the first is exhausted the second will be inactivated and the process will go on until either metallic ions or Versene are used up. Page 7 of Section I of Bersworth's Technical Bulletin No. 2 gives a table which shows the order of chelation of some of the common metals at various pH's. Send for it.

### VERSENES* — POWERFUL CHELATING AGENTS

The Versenes, made only by the Bersworth Chemical Company under processes originated, developed and patented by F. C. Bersworth, are the most powerful chelating agents known. They are exceptionally stable at high temperatures and all pH's. Quality standards of manufacture are so high that uniform complexing power is guaranteed for *either* sample or carload quantities. Ask for Technical Bulletin #2. Write Dept. B for samples. Chemical counsel available.



"Chemistry's most precise chemicals"

VERSENE* WATER TEST KIT. Tells Total Hardness in 2 minutes. Accurate to 1 grain per gal. Versenate method. Complete with instructions $3.00 Postpaid.

*Trade Mark Registered

**BERSWORTH CHEMICAL COMPANY**

FRAMINGHAM, MASSACHUSETTS

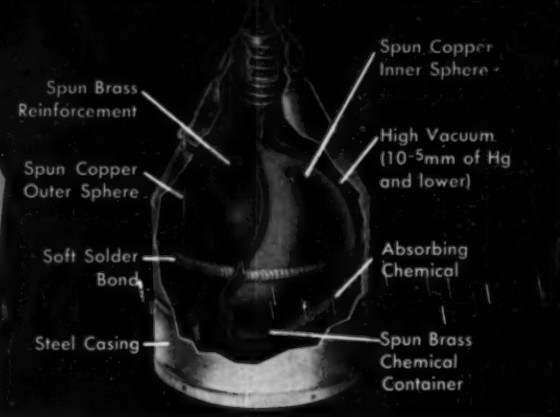
Warehouse Stocks

Providence, R. I. – George Mann & Co., Inc. • Chicago – Kraft Chemical Co. • San Francisco – Los Angeles – Griffin Chemical Co. Charlotte, N. C. – C. S. Tanner Co. • Brooklyn, New York – Siegel Chemical Co. • Dallas – Houston – New Orleans – St. Louis – Tulsa Salt Lake City — Wasatch Chemical Co. • Oklahoma City – Wichita – Borado & Page, Inc.

COPYRIGHT 1952 BERSWORTH CHEMICAL CO.

# It's COLD inside these liquid gas containers...

## *and polished copper helps keep 'em that way*




Cutaway section of a Hofman "Standard" Liquefied Gas Container, made in a range of sizes from 5 to 2000-liter capacity.



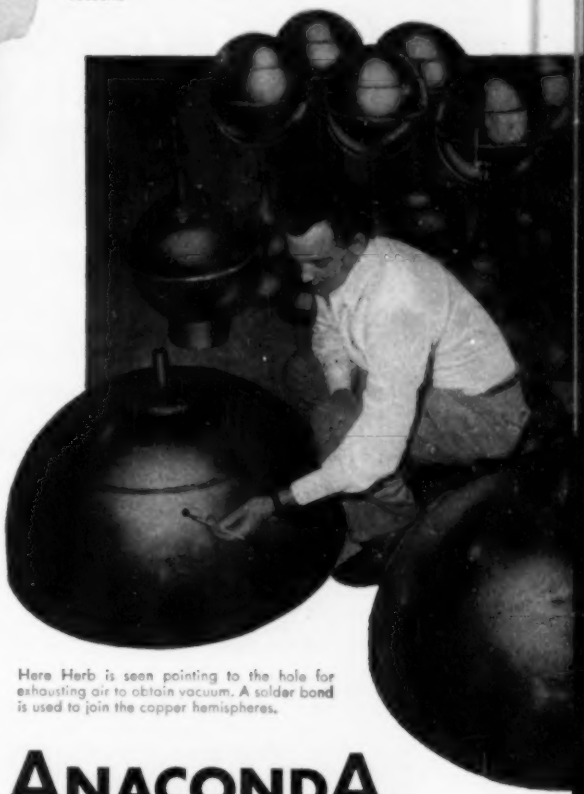
This is Herb Basewit, design draftsman of Hofman Laboratories, Inc., holding an unretouched polished copper inner shell for a 25-liter container. A perforated spun-brass dish soldered on one end holds a chemical which absorbs any leakage of gas into the vacuum.

IN THE STORAGE and transportation of liquefied gases such as air, oxygen, nitrogen, hydrogen and helium, evaporation losses are the big problem (containers can't be sealed because of explosion risks). If insulation is not adequate for the *minus*-452 F temperatures encountered, losses are costly.

Hofman Laboratories, Inc., of Newark, N. J. took a big forward step and made some radical changes in container design. Resembling a giant picnic vacuum bottle, the "Standard" Hofman Container is constructed of an inner and outer copper sphere separated by an extremely high vacuum. Bulky insulation is eliminated and, through the use of polished copper, surface radiation losses are greatly reduced.

Here, as in many other industrial applications, copper does a multi-purpose job better than any other metal by providing: (1) the ductility and malleability necessary for deep-spinning the hemispheres, (2) an unequalled metal for soldering, and (3) a smooth-surface, fine-grain metal that will readily take a mirror-like finish.

Anaconda Metals are made by The American Brass Company, General Offices: Waterbury 20, Conn. 5223



Here Herb is seen pointing to the hole for exhausting air to obtain vacuum. A solder bond is used to join the copper hemispheres.

# ANACONDA

## COPPER and BRASS




**Eagle-Picher Insulations offer more heat-conserving efficiency per dollar**

*Eagle-Picher Industrial Insulations are the natural choice of smart-thinking purchasing agents, plant engineers and other executives who are concerned with production efficiency and economy. They rely on Eagle-Picher Insulations to cut costs... to provide equipment with the highest possible thermal efficiency... to help guarantee precise temperature control.*

EAGLE EP PICHER

## Eagle-Picher Insulations are top-flight performers every time!

**1** **You save time, power and money with this hard-working team* of outstanding insulations:**

*Insulating Felts • Supertemp Blocks • Blankets • Loose Wool • Pipe Covering • Stalastic • Insulating Cements • Fireproofing Cement • Diatomaceous Earth Block.*

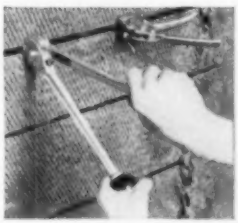
**2** **Eagle-Picher authorized contractor-distributors are skilled thermal engineering specialists.**

*They can help you control temperatures accurately and efficiently. They know how to help you solve difficult insulation problems.*

**3** **Eagle-Picher insulations are available where and when you need them.**

*Fast delivery is assured by authorized distributors strategically located from coast to coast.*

**A typical team of hard-working materials*



**Eagle-Picher Mineral Wool Blankets**—The answer to the problem of efficiently insulating flat or curved surfaces on larger types of heated equipment. Mineral wool is felted and secured with flexible metal fabric. Outstanding physical and chemical stability for maximum resistance to water, steam, corrosive fumes and normal vibration.




**Eagle-Picher Super "66" Insulating Cement**—An all-purpose, rust-inhibitive, extra-adhesive insulating cement. Provides great coverage... retains thermal efficiency. Dry coverage, 50-55 sq. ft. 1 inch thick per 100 lbs. Efficient up to 1800 F. Reclaimable where temperatures do not exceed 1200 F. Easily applied on all kinds of surfaces.



**Eagle-Picher Insulseal**—Protects insulation with a tough, weatherproof coating. For temperatures up to 450 F. Smooth troweling qualities assure uniform coverage, proper thickness. Protects against air infiltration, fumes, rain, snow and vibration... withstands severe all-weather service. Dries to a smooth rich black. Washable.

# THE EAGLE-PICHER COMPANY

*Since 1843 • General offices: Cincinnati (1), Ohio*

*Insulation products of efficient mineral wool—for a full range of high and low temperatures. Technical data on request.*

"Buffalo" *Tips on Better Pumping*

# FOR BEST RESULTS,

## Include ALL Information In Your Requests For Quotes on Pumps

A request containing too little information on a proposed pumping job results in one of two things: the supplier has to assume certain facts, or engage in time-consuming correspondence to get those facts. Complete information IN THE BEGINNING assures your getting the right pumps in the shortest time, and often enables the manufacturer to suggest an alternative which is cheaper and more efficient.

This information should include:

1. Description of the liquid:
temperature, corrosive and/or abrasive characteristics, specific gravity, viscosity and vapor pressure under service conditions, and if possible a chemical analysis. This enables the supplier to recommend the right trim, also the right type and desivn of pump for the job.

2. Capacity—both operating and maximum—in gallons per minute—
so that a pump may be selected within the range of highest efficiency, yet the sufficient margin for safety.

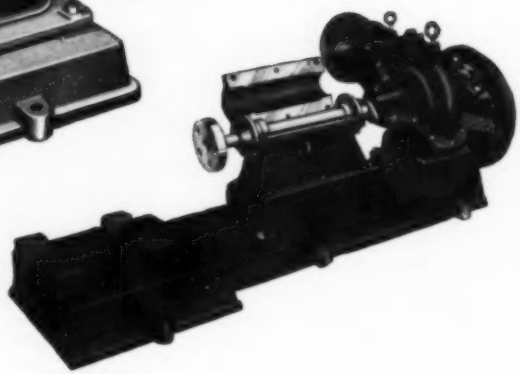
3. Type of drive (direct or belt), and type of driver (engine, turbine, motor).

4. Discharge pressure or head of liquid to be pumped.

5. Suction lift or suction head.



*Left, a "Buffalo" Full Ball Bearing Single Suction Pump Available in special alloys for the chemicals you handle. Write for Bulletin 976-D for full engineering data.*



*Right—"Buffalo" Chemical Pumps are available with medium or hard rubber lining, depending on the acid to be handled. Recommended for chlorinated solutions, concentrated hydrochloric, etc. A complete line of chemical pumps is described in Bulletin 982.*

*Write for your copy!*

"Buffalo" **BUFFALO PUMPS INC.**

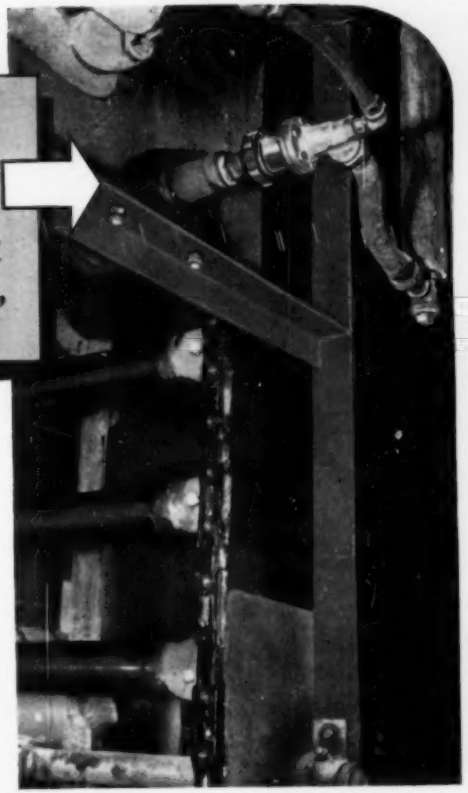
501 BROADWAY, BUFFALO, NEW YORK

**Canada Pumps Ltd., Kitchener, Ont.**

*Sales Representatives in all Principal Cities*

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

# "Barco Revolving Joints give us the PERFORMANCE we want on asphalt coating rolls!"

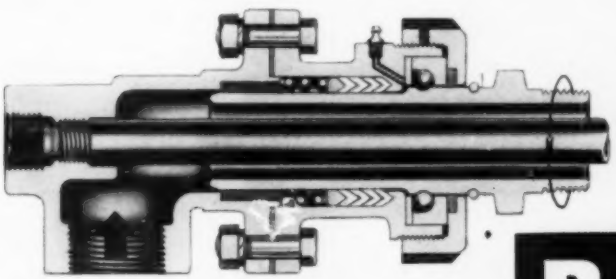


The above picture shows one of the Barco joints used by the Lloyd A. Fry Roofing Co., Summit, Ill., on machines used to apply hot asphalt to roofing paper.

**Says CHIEF ENGINEER**
**Francis Nelson of**
**Lloyd A. Fry Roofing Co.,**
**Summit, Illinois**

Operating engineers throughout the country are reporting the benefits they receive from Barco's new *improved* Type IBR Revolving Joints. These are benefits that come from the *correctness* of Barco's design. There is minimum increase in torque (friction) under increased steam pressure—thanks to Barco's exclusive "CTR" V-type seal rings and ball bearings. Also note the wide spacing between bearings which holds bearing loads and wear to a minimum.

Barco builds a complete line of standard revolving joints in sizes ranging from ½" to 2" and special in sizes to 5". Pressures to 250 psi, steam, or 1000 psi, hydraulic. Speeds to 2500 rpm. *Barco Engineers are at your service; ask for recommendations.*





For information about Barco Revolving Joints, ask for Bulletin 300.

- Better Temperature Control where steam is used for heating rolls, due to better circulation.
- Free-Floating, Low Torque Installations.
- Up to 50% Power Savings.
- Exclusive "CTR" V-Type Seal Rings—*chemically inert.*
- Ability to Withstand Vibration and Hard Usage.
- Low Maintenance; No Adjusting. Holds seal running or standing.

**BARCO MANUFACTURING CO.**
1816 G Winnemac Ave., Chicago 40, Illinois
*In Canada:* The Holden Co., Ltd.

**BARCO**
*Revolving*
**JOINTS**
For Paper Machine Dryers, Calenders, Paper Converting Equipment

# Applications Unlimited...

## *wherever you need to measure,*

## *. . . choose*

## *ElectroniK Potentiometers*

WHETHER charting the course of an experiment on a laboratory bench, or regulating huge-scale production in a sprawling processing plant, *ElectroniK* Potentiometers point the way to accelerated research, to greater productivity, to higher quality, and to lower costs.

Versatile *ElectroniK* Instruments are supplied calibrated for variables such as pressure, temperature, level, flow, pH, conductivity, speed and motion. A wide selection of instruments provides a choice of indicators, single and multi-point recorders, and a variety of electric and pneumatic



**PRECISION INDICATOR**

centralizes up to 48 different readings on one instrument; just press a button and wide-open scale turns quickly to measured value.



**INDICATING CONTROLLER**

set point and measured values are easily read on $2\frac{1}{2}$-foot circular scale. Supplied for on-off and proportional electrical control.

● *Important Reference Data...*

# *record or control*

controllers from the simplest to the most complex types. In all these, the *ElectroniK* "continuous balance" measuring system, with electronic non-cyclic balancing, affords the peak of speed, sensitivity and service-proved dependability.

Plan now to gain the full benefits of automatic instrumentation throughout your plant. Call in your local Honeywell engineer . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4478 Wayne Avenue, Philadelphia 44, Penna.

## Of special interest to research men . . .

### FUNCTION PLOTTER

automatically charts temperature vs. expansion, speed vs. torque, stress vs. strain. One variable actuates the pen, the other actuates the chart drive.

### DUPLEX RECORDER

simultaneously records any two independent variables. Two pens actuated by separate measuring systems can both travel full width of the chart.

### ELECTROMETER

records currents as small as $10^{-16}$ amperes, for measurements with ionization chambers, spectroscopes, etc.; features fast response, low noise, high stability.





### Recorders

Circular chart type with 28⅝" scale can be read at a distance. Strip chart type records as many as 16 points. Scanners available for larger number of points. Pen speeds as fast as one second.

### Electric Controllers

Circular chart and strip chart types are supplied for on-off and proportional control . . . Electr-O-Line for position-proportioning, Electr-O-Pulse for time-proportioning.

### Pneumatic Controllers

Choice includes on-off control, Limited Throttlor and Full Throttlor controllers with manual reset, Air-O-Line Controller with automatic reset. Rate action is optional.

MINNEAPOLIS
**Honeywell**
BROWN INSTRUMENTS
*First in Controls*

**For a brief description of all Honeywell instruments, write for Composite Catalog 5000.**

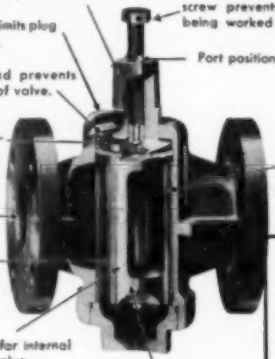
# We Make ALL Types of PLUG VALVES

## ONE OF THEM IS THE RIGHT VALVE FOR YOUR NEEDS

## HOMESTEAD-REISER "Self-Seald" LUBRICATED PLUG VALVES



Straight-way— Worm & Gear Operated






Flow Changer— Non-lubricated

**HOMESTEAD CAM-SEALD** (dry seat)

**HOMESTEAD LEVER-SEALD** (quarter turn)

### How the Amazing "Self-Seald" Principle Works

Homestead-Reiser's patented "Self-Seald" principle is, we believe, the simplest and most effective sealing principle yet developed for lubricated plug valves.

In addition to a full lubricant seal around the ports, and around the top and bottom of the valve, the wedge-action of the divided plug under line pressure, causes the finely-finished surfaces of both segments of the plug to press outward against the sealing surfaces of the body.

This self-sealing action keeps the plug surfaces in contact with the mirror-like bore of the body. The plug automatically adjusts itself for wear, thus assuring extra long life and maximum leakless service.

**For complete information, sizes and prices, write for Catalog 39-S. No obligation.**



Straight-way— Flanged or Screw Ends



Straight-way— Flanged or Screw Ends



Three-way— Screw or Flanged Ends



Four-way— Flanged or Screw Ends

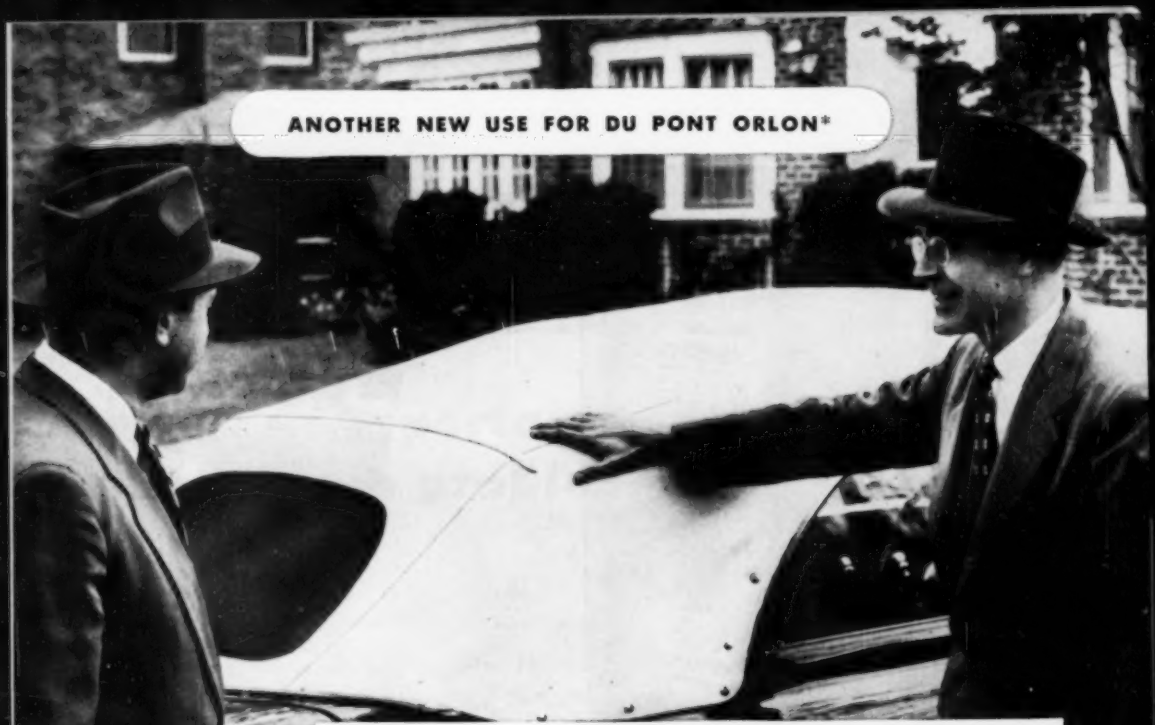


Four-way— Flanged or Screw Ends



Three-way— Flanged or Screw Ends

**HOMESTEAD VALVE MANUFACTURING COMPANY**
P. O. BOX 13 "Serving Since 1892" CORAOPOLIS, PA.



ANOTHER NEW USE FOR DU PONT ORLON*

# Tops in performance:

## SUN-RESISTANT "ORLON"

The top you see on this convertible will still be new-looking after years of use. The reason is it's made of "Orlon" acrylic fiber—the new Du Pont fiber which resists the harmful effects of the sun's rays, chief cause of deterioration in fabrics for convertible tops.

Tests under the strong Florida sun proved that tops of "Orlon" will take years of continual exposure without appreciable damage. They stand up well under flexing and will not balloon excessively at high speeds. Convertible owners report that tops of "Orlon" are breaking past performance records for durability. Wet or dry, tops of "Orlon" keep their shape. They are easy to clean with solutions of mild soap or detergents.

You may be able to make a better product or improve a production process with "Orlon." Besides resisting sunlight, this Du Pont fiber withstands the damaging effects of heat and acid; has high strength, wet or dry; and good abrasion and stretch resistance.

Fabrics of "Orlon" have a broad range of uses including convertible tops, industrial thread, hydraulic press cloths, and work clothes. Perhaps "Orlon" can help you in your business. Write E. I. du Pont de Nemours & Co. (Inc.), Textile Fibers Dept., Room N-2504U, Wilmington 98, Delaware.

*Du Pont's trade-mark for its acrylic fiber (Du Pont makes only the fiber . . . not the fabric or finished product)

DU PONT

REG. U. S. PAT. OFF.

150th Anniversary

BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY




WHAT *Life-Lines* REALLY DELIVER IS MORE SERVICE...LESS SERVICING

# New chemical booklet

## answers important motor and control application problems

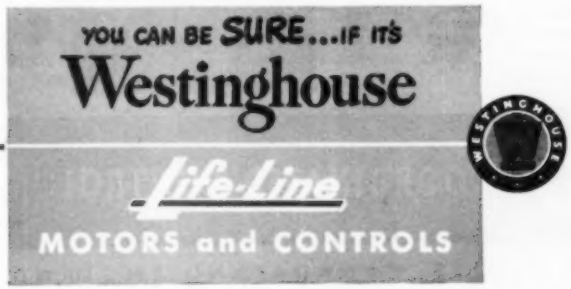
**You'll see answers to typical problems like these:**

*the problem of corrosion . . . of hazardous locations . . . of dust and dirt . . . of outdoor service . . . of shock and vibration*

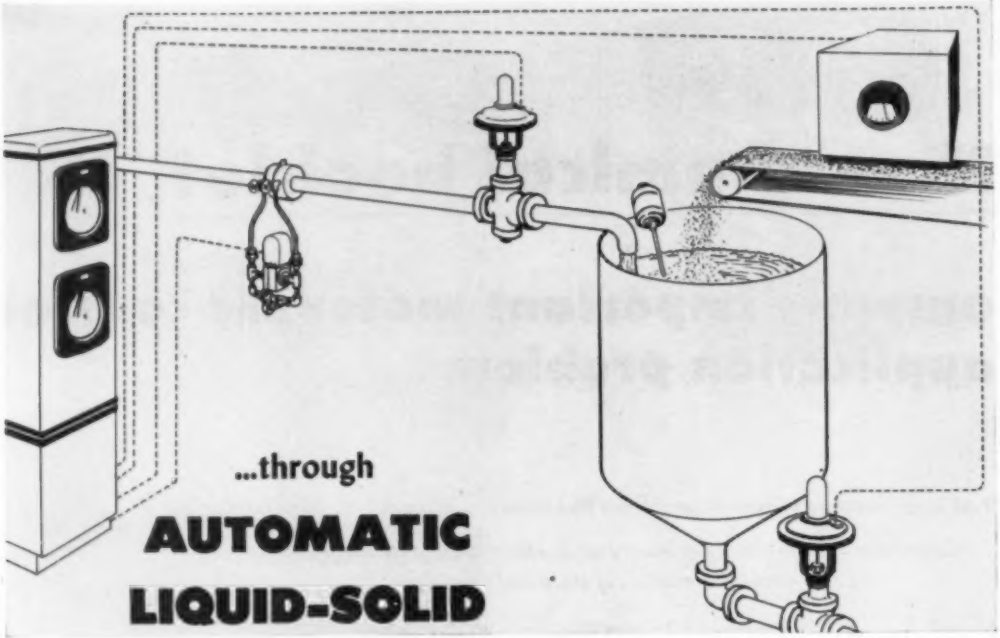
**In addition, are discussions on lubrication, maintenance, installation . . . on centralized motor and control. In fact, it is the purpose of this booklet to analyze major motor and control application problems, and to provide solutions.**

**Also included, is information on Westinghouse motor and control equipment for chemical processing. You'll see why Life-Line chemical motors provide the best protection . . . how starters save servicing time. A comprehensive list of available literature with data is included, plus a postage-paid reply card for your convenience in ordering additional information.**

**Get the facts on the most complete and most advanced line of motors and controls available today. Ask your Westinghouse representative for your free copy of "Motors and Controls in the Chemical Industries," B-4792, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.** J-21698



# NEW OPPORTUNITIES in continuous processing



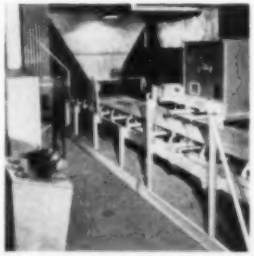

## RATIO CONTROL... by Foxboro

Many a troublesome batch process can be converted to continuous operation — with resulting economies and product improvement — by installing Foxboro Liquid-Solid Ratio Control. This simple, accurate system has been thoroughly proved in use on such processes as the extraction, dissolving, or reaction of materials.

Typical examples include the proportioning of acid feed to phosphate rock in the production of phosphate fertilizer, and the proportioning of water to the feed of cossettes (sliced beets) in the production of beet sugar. *Wherever ratio-ing the quantity of liquid reagents to a varying rate of solid chemicals being delivered by a conveyor belt is desirable, this fully automatic system simplifies the operation and improves the efficiency of the process.*

In this system, a Foxboro Recording Controller receives a continuous measurement of weight of the solid material (from a Foxboro Pneumatic Motion Transmitter incorporated in a Merrick Weightometer located above the conveyor belt), and also receives a continuous measurement of liquid flow from a Foxboro d/p Cell or mercury manometer. The desired ratio between solid and liquid can be readily set by a dial in the instrument which, in turn, controls the liquid flow.

The efficiency-boosting advantages of Foxboro Ratio Control are now being realized by a number of leading companies. If you have a similar problem, learn how these advantages may be achieved for your plant. Write for engineering data. **The Foxboro Company, 366 Neponset Ave., Foxboro, Mass., U. S. A.**



*This illustration shows Foxboro Ratio Control at a large beet sugar plant. A Merrick Weightometer equipped with a Foxboro Pneumatic Motion Transmitter appears in the foreground.*

**FOXBORO** REG. U. S. PAT. OFF. **COORDINATED CONTROL**

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

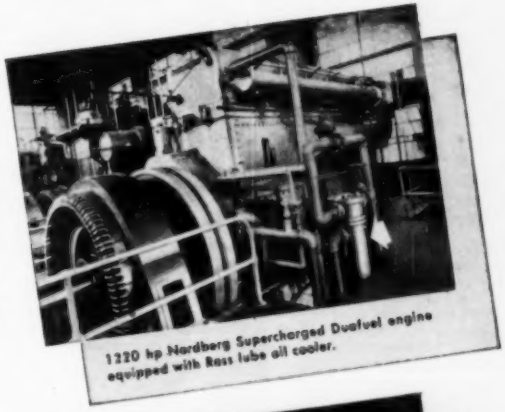
# again Ross Exchangers for

# temperature safety

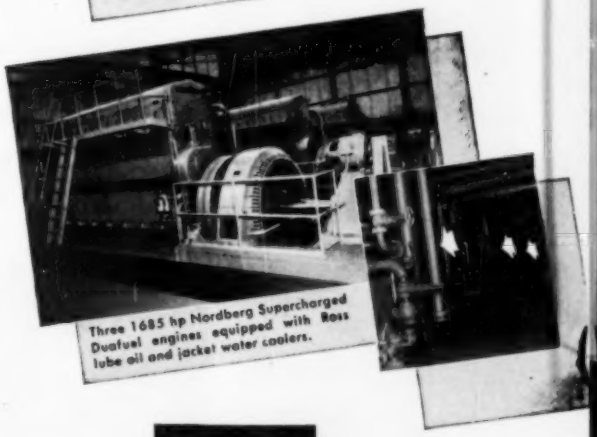
## in these Nordberg engine installations



3850 hp Nordberg Diesel engine equipped with Ross lube oil cooler.



1220 hp Nordberg Supercharged Duafuel engine equipped with Ross lube oil cooler.



Three 1685 hp Nordberg Supercharged Duafuel engines equipped with Ross lube oil and jacket water coolers.

A vital part of the lube oil circuit in each of these Nordberg engines is a Ross Type CP Exchanger. On it, along with other key components, rest the critical responsibilities of adequate bearing lubrication and piston cooling.

Naturally, with a reputation for dependable, low cost, lasting service, Nordberg engines require components of like qualities . . . the very reasons Ross Exchangers are used so extensively.

Long experienced with the successful performance of Ross Exchangers in *all* types of municipal and industrial power applications, Nordberg Manufacturing Co., *knows* that lube oil and jacket water temperatures are in safe hands when Ross is selected . . . as do the plant engineers who operate these rugged Diesel, gas and Duafuel engines.

Among engine builders *everywhere,* there is a distinct preference for Ross Exchangers. On engines, compressors, turbines, speed increasers, reduction gears. In generating stations, oil fields, pipelines, locomotives, chemical plants and aboard ship. For, engine builders are continually looking to Ross for the ready answer. *And they always get it* . . . either in the form of a fully standardized unit available from stock, or one that is custom-assembled from stocked parts and sub-assemblies.

Literature is available to describe Ross standardization in detail. Ross Engineers are available to work out your problems with you. Write.

ROSS HEATER & MFG. CO., INC., Division of American Radiator & Standard Sanitary Corp., 1411 West Avenue, Buffalo 13, N. Y. In Canada, Horton Steel Works, Limited, Fort Erie, Ont.

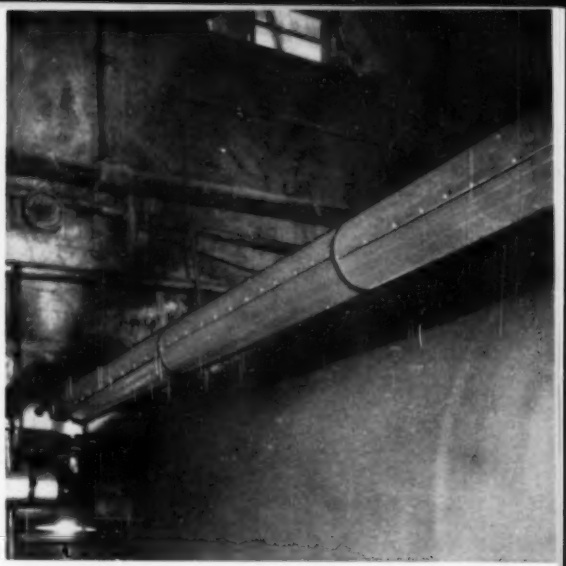



*Serving home and industry*

AMERICAN STANDARD · AMERICAN BLOWER · ACME CABINETS · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON



IN PETROLEUM REFINERIES like this a new kind of aluminum jacketing is used to protect the insulation on hot and cold lines. It is known as Childers Aluminum Jacketing and is especially engineered to combine the long life and weather resistance of aluminum with a low first cost. It goes on quick and easy—can be used and re-used. It is made of tough but flexible .006" 35 aluminum alloy, so it handles easily and requires no shop forming.

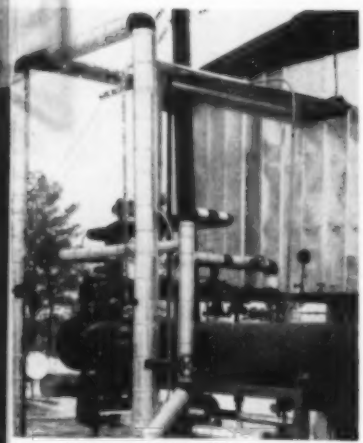


IN CHEMICAL AND PAPER plants: engineers are finding new uses for this easy-to-handle jacketing. Childers Jacketing here is in use at Scott Paper Company's tremendous Chester, Pa., plant. The insulated line passes between fast moving rolls carrying the felt used in paper making both above and below the line. The Aluminum Jacketing protects against paper dust and water, both of which are always present in the manufacture of paper. The jacketing also appreciably diminishes the possibility of the spread of fire which might strike across ordinary canvas jacketing.

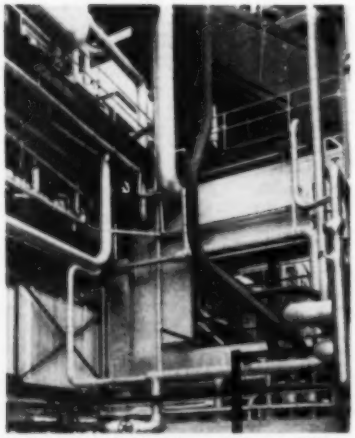
## Engineered for outdoor lines — new, low-cost aluminum jacketing now used in 567 processing plants

The new kind of aluminum jacketing for insulated lines shown in the pictures on this page is Childers Aluminum Weatherproof Jacketing. Write for samples and full details, no obligation. Childers Manufacturing Co., Dept. CE-3, 3620 W. 11th St., Houston 8, Texas.

*Under CMP regulations, Childers is a Class II product, the use of which is not restricted.*



IN FOOD PROCESSING plants such as this Minute Maid Corp. unit at Plymouth, Fla., Childers Jacketing is useful for both indoor and outdoor installations. Its clean, shining appearance and ease of washing are extra advantages.



IN POWER PLANTS—indoors and out—Childers Jacketing is an ideal material for protecting insulation. This is a big outdoor installation in the South. This jacketing needs no painting, and the gleaming aluminum surface makes for "good housekeeping" in any utility or institutional power station.




ALMOST ANYWHERE you have insulated lines in your processing plant, consider this specially engineered jacketing. It is flexible, easy-to-handle; yet it has the appearance values and the weather resistance that are inherent in aluminum. Write to address shown above for full details.

Advertisement

# You Pay More For HEAT-FAG...




## ... than for the blower that keeps men cool

When hot, stagnant or fume-filled air distresses your men, your production suffers too.

Give men around furnaces or hot processes, or in confined areas, a steady supply of fresh, cool air with Coppus Blowers and Exhausters and watch their efficiency jump to a more profitable level.

There's a portable, easily adaptable Coppus "Blue Ribbon" product for practically any fresh-air requirement. The Coppus "Blue Ribbon" is the sign of precision workmanship and trouble-free, long-lasting operation. Check and mail the coupon for exact information. Sales offices in THOMAS' REGISTER. Other "Blue Ribbon" Products in CHEMICAL ENGINEERING CATALOG, REFINERY CATALOG, BEST'S SAFETY DIRECTORY, MINING CATALOGS.

## OTHER COPPUS "BLUE RIBBON" PRODUCTS



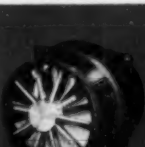
HORIZONTAL TURBINE
Six frame sizes —
1 to 150 horsepower



VERTICAL TURBINE
Six frame sizes —
1 to 150 horsepower



FANMIX GAS BURNER



FANMIX GAS-OIL BURNER

**MAIL THIS COUPON** To Coppus Engineering Corp., 226 Park Avenue, Worcester 2, Mass.

**PLEASE SEND ME INFORMATION ON SUPPLYING FRESH AIR TO MEN WORKING:**

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes.
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens.
- ☐ on steam-heated rubber processes.
- ☐ on boiler repair jobs.

COOLING:

- ☐ motors, generators, switchboards.
- ☐ wires and sheets.
- ☐ general man cooling.
- ☐ around cracking stills.
- ☐ exhausting welding fumes.
- ☐ stirring up stagnant air wherever men are working or material is drying.
- ☐ drying of walls, sheets; etc., after treated with coating material.

NAME .....

COMPANY .....

ADDRESS .....

CITY .....

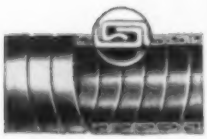
(Write here any special ventilating problem you may have.)

## Wherever chemical products must be conveyed . . . . .





# CMH



*CMH convoluted hose is available in a variety of types including square inched, ball bearing and fully interlocked . . . in steel, bronze and other alloys. Sizes up to 12", I.D.*



*CMH corrugated steel and bronze hose is available in standard sizes from ½" through 12" I.D. for burst pressures to 12,000 psi, temperatures to 1000° F. Stainless steel types also available.*

## FLEXIBLE METAL HOSE makes the job easier!

AT THE source, in transport or in the processing plant, CMH Flexible Metal Hose can simplify handling chemical products. Its high degree of flexibility combined with the rugged durability of metal makes it ideal for any connections that involve motion, vibration or misalignment. Used as vibration connections, as loading and unloading hose, as tank settling connections and in a score of similar applications, CMH Flexible Metal Hose provides the dependability so vital to the chemical industry. Freedom from deterioration and resistance to wear and tear assures greater over-all economy.

Write for descriptive literature giving full information on CMH Flexible Metal Hose. There is no obligation.

**CHICAGO METAL HOSE Division**

**Flexonics** *Corporation*

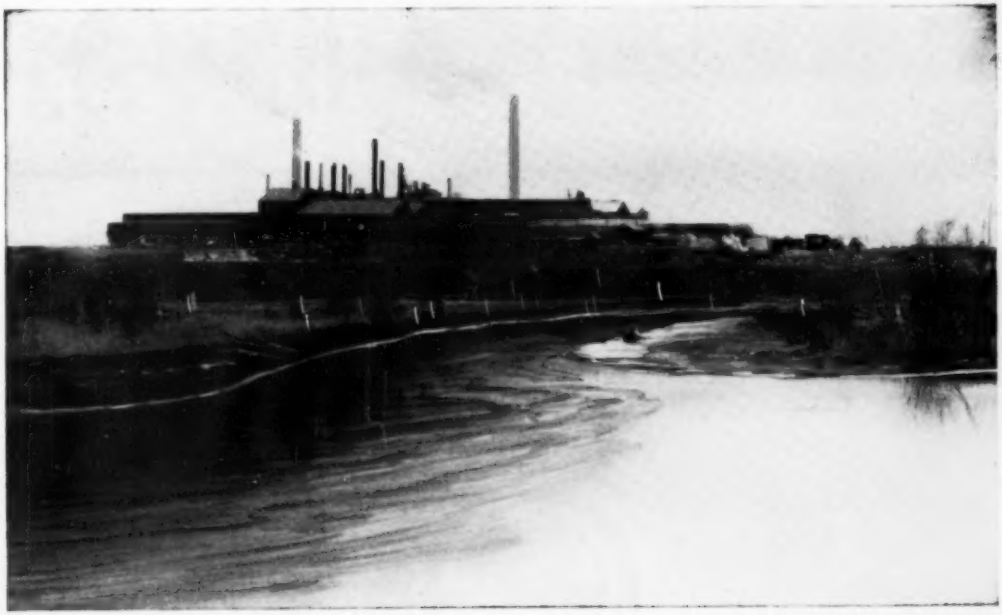
**1317 S. Third Avenue · Maywood, Illinois**

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals · Expansion Joints for Piping Systems · Stainless Steel and Brass Bellows · Flexible Metal Conduit and Armor · Assemblies of These Components

In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ontario

Flexon identifies CMH products that have served industry for over 50 years.

CMH



# WORRIED ABOUT WASTE DISPOSAL?

## Bailey Meters Help you to Reduce Pollution

● The disposal of industrial wastes without stream pollution calls for careful planning and continuous vigilance.

That's where Bailey Meters and Controls come in. We measure the flow and pH of sewage, sludge, and industrial wastes flowing in open channels or pipe lines. These and other factors, such as levels, rates of chemical feed, and flow of air, may be co-ordinated into a completely automatic system for the treatment and disposal of waste materials.

When you want fast, complete and authoritative answers to the measurement and control aspects of your waste disposal problems, reach for your phone and call your local Bailey Engineer. Offices in all principal industrial centers.

P-24



**BAILEY OPEN CHANNEL METERS**

These indicating, recording and integrating meters are suitable for measuring industrial wastes, sewage, sludge, corrosive liquids, and irrigation water flowing in all types of open channel primary metering devices, such as Venturi flumes, weirs, or nozzle flumes. Electric or pneumatic telemetering permits location of receivers wherever desired. Ratio of flows and chemical feeds may be controlled automatically.

BAILEY METERS

**BAILEY METER COMPANY**

1054 IVANHOE ROAD
CLEVELAND 10, OHIO

*Process Controls*

TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO



# . . where space is a problem

. . . the Fairbanks-Morse Axial Air Gap Motor is the solution to your motor drive problems. For this unique motor is 40% shorter . . . 30% lighter than conventional models.

Like all motors that bear the Fairbanks-Morse Seal, the Axial Air Gap has the traditional strength, balance and electrical stability that assure you maximum service life.

Whether you are interested in a single motor, or thousands—one type and size, or a variety of types and sizes—you'll find that Fairbanks-Morse Motors are designed and built to fill your needs.

When you look for electric motors—for standard or unusual applications—*always* look for the Fairbanks-Morse Seal. For over 120 years it has stood for the finest in manufacturing integrity to *all* industry. Fairbanks, Morse & Co., Chicago 5, Ill.




**FAIRBANKS-MORSE,**

***a name worth remembering***

ELECTRIC MOTORS AND GENERATORS • DIESEL LOCOMOTIVES AND ENGINES • PUMPS • SCALES • HOME WATER SERVICE EQUIPMENT • RAIL CARS • FARM MACHINERY • MAGNETOS

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# U.S.I. CHEMICAL NEWS

June ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1952

## 20th Anniversary

**1932 · 1952**

This is the 20th anniversary issue of U.S.I. CHEMICAL NEWS. This series for chemists and executives of the solvents and chemical consuming industries started in June 1932. For a brief history of the "NEWS," see the article at the bottom of column one on this page.

## Make Plasma Substitute From Discarded Red Cells

Scientists believe they have found a substitute for blood plasma in a new substance derived from red blood cells, according to a recent announcement. The product consists of proteins taken from red cells and prepared so that they can dissolve in the blood stream and feed the body in the same way that plasma does. Since red cells are largely wasted in present processes, the new substance is cheaper to produce than plasma and will increase the protein yield of each blood donation by more than three times, it is claimed. The protein part is said to be the most valuable when plasma is given for nutrition or to combat shock.

## New Chemical Weed-Killer Produced by U.S.I.

### New Herbicide, Applied to Soil as Pre-Emergent Spray, Controls Grassy Weeds in Many Broad-Leaf Crops

Marking the latest expansion in its aggressive program to provide the agricultural world with safe and effective controls, U.S.I. recently announced its commercial production of IPC, a new chemical weed killer. Up to now, U.S.I.'s agricultural line has been concentrated on a wide range of insecticide and insectifuge materials. IPC is the first herbicide to be added to U.S.I.'s long list of valuable products.







**U.S.I. Tests Demonstrating IPC's Effectiveness**

IPC (isopropyl N-phenyl carbamate) is a new type of weed killer which is designed to be applied as a pre-emergent spray to the soil rather than to the weeds themselves. In most cases, the chemical acts as a selective grass killer, eliminating grassy weeds from many broad-leaf crops without harming the valuable plants. IPC is applied evenly over the soil surface, after which moisture from rains or irrigation water, carries it into the root area of the soil. The chemical acts on the expanding embryos of seeds as well as on root systems that have already developed so that

MORE

## *Vitamin $B_{12}$ Counteracts Growth Depressing Action Of Alfalfa in Chicks*

Recent research in poultry nutrition is reported to have shown that vitamin $B_{12}$ is effective in overcoming the growth inhibiting properties of alfalfa. Dehydrated alfalfa meal is a common ingredient of practical poultry rations. Feeding of alfalfa to chicks is said to be subject to limitation, however, because of the growth depressing effects it has when fed at high levels. In experiments conducted at a leading midwestern college, vitamin $B_{12}$ was found to be capable of counteracting the unknown toxic factors in alfalfa, and to produce in chicks a marked improvement in livability and growth under the experimental conditions.

## U.S.I. Chemical News Celebrates 20th Anniversary with This Issue

### Famed News Sheet Has Served Industry Since June 1932

With the current issue, U.S.I. proudly marks the 20th anniversary of its popular news-insert advertisement, U.S.I. CHEMICAL NEWS. This issue you are now reading is the 241st "blue sheet" to be published since June 1932 when the record-breaking series began in leading chemical and drug publications. The name on the masthead then was SOLVENT NEWS, U.S.I. being at that time primarily a producer of solvents and plasticizers. Its purpose – then a new idea in advertising – was to furnish chemists, purchasing agents, and executives of the solvent-consuming industries with up-to-date information on markets, prices and technical developments in their field. Industry immediately recognized the "NEWS" as a valuable service. Soon after it appeared, inquiries concerning news items were averaging a hundred per month. At the present time, more than 500 inquiries are received each month.

As U.S.I. continued to broaden its activities beyond the manufacture of solvents and plasticizers, the scope of SOLVENT NEWS also expanded. In May 1940, the name was changed to U.S.I. CHEMICAL NEWS, a reflection of the company's growth in the chemical and

MORE


SOLVENT NEWS

ALCOHOL PRICES RELEASED TO THE INDUSTRY FOR THIRD QUARTER

NO CHANGE FROM PRESENT LEVELS

ETHYL ACETO ACETATE DEMONSTRATES VERSATILITY

DU PONT OFFERS NEW WATERPROOF MATERIAL

NEW LACQUER LINSEED OIL ANNOUNCED

**The first U.S.I. "blue sheet"—June, 1932.**

## Polyvinyl Acetate Makes Concrete Mortar Stronger

Recent work has reportedly shown that polyvinyl acetate can be added to concrete mortar to increase strength of the cured products as much as three times over that of pure cement mixes. PVA mortars are also claimed to be superior to pure concrete in having greater resistance to abrasion and higher impact strength, and in not cracking under sudden loads and thermal stresses. Best results have been obtained with a polymer to cement ratio of 1 to 5. No plasticizer is required in adding the plastic. Uses suggested for PVA mortars include floor toppings and road surfacings, wall and ceiling cement plasters, and masonry surfaces where self curing and bond strengths are extremely important.

June ★ **U.S.I. CHEMICAL NEWS** ★ 1952

## CONTINUED New Weed-Killer

it is able to prevent as well as kill weed growth. When the roots or seeds of affected grasses come into contact with even minute amounts of IPC, cell division within the plants is seriously disrupted and growth is arrested. If the plants are small, they generally die within two weeks. Older grasses take longer to die, but their growth is effectively stopped upon exposure to the chemical.

The herbicide will remain active in most soils for periods of 30 days or more. It does not build up in the soil, however, so that it has no cumulative effect. Generally, low temperatures and low incidence of soil bacteria tend to lengthen the life of the material in the soil. IPC does not move laterally in the soil from the spot to which it is applied. One of its principal advantages is its latitude of safe dosages which results from its extreme selective phytotoxicity. Uniformity of application, while desirable, is not as critical as with most other herbicides.

### Stable, Non-Corrosive

U.S.I.'s product, which is furnished in 98 percent minimum purity, is in the form of fine, easily dissolved needle-like crystals, white to light gray in color. The compound is stable at storage conditions for indefinite periods, and it is non-corrosive to metals normally employed in handling and application equipment. IPC is apparently not toxic to humans or animals, but the ordinary precautions in regard to skin contact and continued inhalation should be observed in handling it as with any other organic chemical material.

## *Nucleus Has Orbits, Too*

Recent nuclear research is reported to indicate that protons and neutrons within the nucleus have regular orbits and closed shells in much the same manner as external electrons. Many quantitative aspects of radioactive decay can be explained by shell effects, with closed shells accounting for the unusual stability of nuclei of some atoms, it is said. Small energy effects can be related to changes in sub-shell structure within the nucleus.

## CONTINUED *20th Anniversary*

fast growing synthetic resin fields. Today, except for wider news coverage, the original editorial policy of "service to industry" is still followed.

News sources for U.S.I. CHEMICAL NEWS, called by some readers "the front page of the chemical industry," are as varied as those of larger technical publications. Manufacturers regard it as a primary outlet for news of their new products and are quick to forward their announcements to the editor. The "NEWS" has often scooped its bigger counterparts on stories. Research men and engineers are on record as saying that they never miss the "Technical Developments" column, which in 20 years has carried announcements of more than 2,400 new products and processes.

The series has never missed a month since it started. All 241 numbers have been printed in blue on distinctive light blue stock — a trade mark that was maintained only with difficulty during war-time scarcities. At one point, it was even necessary to use an over-all color plate to pre-print the light blue because paper of that color could not be obtained.

U.S.I. CHEMICAL NEWS appears regularly in seven publications, giving it a circulation of more than 180,000. An additional 12,000 members of chemical and related industries receive the "NEWS" in the form of a 4-page mailing piece.

## New Booklet Describes Synthetic Waxes, Uses

Synthetic waxes with a wide range of physical properties are fully described in a new catalog, recently made available. The waxes include amide and ester types which range in hardness from soft to brittle and in melting points from 55° C. to 143° C. Use data are listed for such applications as coatings, lubricants, anti-tack agents, electrical insulation, flatting agents, and drawing compounds.

## TECHNICAL DEVELOPMENTS

*Information about manufacturers of these items may be obtained by writing U. S. I.*

**New polytetrafluoroethylene pipe, reinforced with glass fiber,** is claimed to be rigid and strong in wall sections as thin as 0.030 in. and to be suitable for use with virtually every known chemical. **(No. 809)**

**A new rubber-phenolic varnish** is said to permit the manufacture of laminated plastics with two to three times the impact strength of those made with conventional varnishes. Gears, tubing, castor wheels, and paper coatings are among expected applications. **(No. 810)**

**A liquid polyvinyl chloride stabilizer,** containing barium and calcium soaps and a synergist, is reported to impart good initial color and clarity, to be efficient under dynamic heat conditions, and to require no pregrinding for complete dispersion. **(No. 811)**

**Metallic lead dust homogenized in heavy-duty grease** is said to provide a new lubricant which resurfaces pitted and scored bearings and gears and forms self-lubricating surfaces over all wearing parts. **(No. 812)**

**Tap water becomes chemically pure** when it is squeezed from a new polyethylene bottle having a special deionizing filter fitted in the neck like a stopper. Filter processes up to 20 gallons and changes color when consumed, according to the manufacturer. **(No. 813)**

**An aluminum tinting paste,** claimed to give a brighter finish than conventional aluminum pigments without interfering with true color values, is now available for use in auto and household finishes. **(No. 814)**

**A new automatic burette,** available in 10 and 25 ml. sizes, can be filled to the zero-mark simply by squeezing the polyethylene reservoir into which it fits. A polyethylene delivery tube is said to offer further safety from breakage. **(No. 815)**

**To make solid derivatives of alcohols and phenols** that can be separated and purified easily, N-bromophthalimide is being offered as a new laboratory reagent. Compound is reported to minimize formation of side products and to be stable and easy to store. **(No. 816)**

**Carbon formation can be prevented in any internal combustion engine or oil burner,** it is claimed, by using a new blending agent in the fuel which liberates free oxygen upon ignition, making the flame cleaner and hotter. **(No. 817)**

**A non-explosive, non-toxic litho blanket and roller wash** for printers contains no carbon tetrachloride or coal tar solvents, is an efficient, quick-drying solvent, and is entirely safe to use, the manufacturer states. **(No. 818)**

**To adhere silicone-treated surfaces** of paper, wood, ceramics, and metals, a new adhesive is available which can be used as efficiently in high-speed gluing machines as any standard adhesive. **(No. 819)**


**PRODUCTS OF U.S.I.**

**ALCOHOLS**
Amyl Alcohol (Isoamyl Alcohol)
Butanol (Normal-Butyl Alcohol)
Fusel Oil—Refined
Propanol (Normal-Propyl Alcohol)

**Ethanol (Ethyl Alcohol)**
Specially Denatured—all regular and anhydrous formulas
Completely Denatured—all regular and anhydrous formulas
Pure—190 proof U.S.P., Absolute—200 Proof
Solox*—proprietary solvent—regular and anhydrous

**ANTI-FREEZE**
Super Pyro* Anti-Freeze
U.S.I. Permanent Anti-Freeze

**ETHERS**
Ethyl Ether, U.S.P.
Ethyl Ether, Absolute—A.C.S.

**ACETONE — A.C.S.**

**ANSOLS**
Ansol* M
Ansol* PR

**ACETIC ESTERS**
Amyl Acetate—Commercial and High Test
Butyl Acetate
Ethyl Acetate—all grades
Normal-Propyl Acetate

**OXALIC ESTERS**
Dibutyl Oxalate
Diethyl Oxalate

**PHTHALIC ESTERS**
Diamyl Phthalate
Dibutyl Phthalate
Diethyl Phthalate

**OTHER ESTERS**
Diatol*
Diethyl Carbonate
Ethyl Chloroformate

**RESINS (Synthetic and Natural)**
Arochem*—modified types
Arodure*—urea-formaldehyde resins
Arolene*—pure phenolics
Arolite*—for special flat finishes
Arolite†—room temperature curing phenolic
Aroplax*—alkyds and allied materials
Aropol*—copolymer modified allyds
Ester Gums—all types
Natural Resins—all standard grades

**INSECTICIDE MATERIALS**
CPR Concentrates: Liquid & Dust
Piperonyl Butoxide
Piperonyl Cyclonene
Pyrenone* Concentrates: Liquid & Dust
Pyrethrum Products: Liquid & Dust
Rotenone Products: Liquid & Dust

**INSECTIFUGE MATERIALS**
Indalone*
Triple-Mix Repellents

**INTERMEDIATES**
Acetoacetanilide
Acetoacet-ortho-chloroanilide
Acetoacet-ortho-toluidide
Acetoacet-para-chloroanilide
Ethyl Acetoacetate
Ethyl Benzoylacetate
Ethyl Sodium Oxalacetate

**FEED PRODUCTS**
Calcium Pantothenate (Feed Grade)
Curbay B.G.*
DL-Methionine (Feed Grade)
Niacin, U.S.P.
Riboflavin Concentrates
Special Liquid Curbay*
U.S.I. Vitamin $B_{12}$ and Antibiotic Feed Supplements
Vacatone* 40

**OTHER PRODUCTS**
Colloidions
Ethylene
Methylene (Pharm. Grade)
Nitrocellulose solns.
PiB*—Liquid Insulation
Special Chemicals and Solvents
Urethan, U.S.P.
Acetaldehyde

*Reg. U.S. Pat. Off. †Trademark Pending

**U.S.I INDUSTRIAL CHEMICALS CO.**
*Division of National Distillers Products Corporation*

120 BROADWAY, NEW YORK 5, N. Y. BRANCHES IN ALL PRINCIPAL CITIES

# DREW TECHNICAL PRODUCTS

Drew produces more than 30 Fatty Acids in volume to meet the specific demands of manufacturers in many fields. Years of close study of fatty acids, plus modern research, production techniques, and equipment give you a product plus in these Fatty Acids.

**LAURIC ACID FOR SHAMPOOS, SOAPS, SHAVING CREAMS, COSMETICS**



DREW LAURIC ACID, distilled, fractionated and stabilized to safeguard color on prolonged heating. Formula ABL (70% Lauric Acid) is widely used in high grade cosmetic preparations, soaps, shampoos and shaving creams. Titre 30°C Minimum. Formulas AB, ABH and A are also popular in this field.

**LAURIC ACID FOR WETTING AGENTS, DETERGENTS, INSECTICIDES**



DREW AAB (85%-90% Lauric Acid). Distilled and fractionated to provide greater efficiency, better composition and superior color stability characteristics.

**LAURIC ACID FOR ALKYD RESINS, FLOOR WAXES, PAINTS**



DREW WECOLINE ABL. Distilled and fractionated coconut fatty acid with high lauric acid content. Shorter average molecular chain length and practically no degree of unsaturation. An ideal ingredient for alkyd resins due to its plasticizing efficiency and non-yellowing characteristics. Especially useful in formulations containing urea or melamine resins. A complete range of coconut fatty acid formulas: AB, ABH and A, are also available for use in the production of alkyd resins.

**STEARIC ACID FOR METALLIC SOAPS and NON-IONIC EMULSIFIERS**



DREW FORMULA 300—hydrogenated, distilled Stearic Acid (approximately 65%). High titre, low iodine value. Excellent color and mild odor. Permits manufacturers to obtain good, light color in finished products at nominal cost. Other grades of Stearic Acids also available up to 90%.

**PLASTICIZER FOR PROTECTIVE COATINGS, ADHESIVES, IMPREGNANTS, INKS**



DREW DP 520. More than a plasticizer: a versatile chemical used to impart flexibility, clearness, toughness, permanence in a wide variety of protein base products. Exceptionally stable against heat and humidity changes.

---

**Drew Fatty Acids are, in many cases, both distilled and fractionated by a continuous process to reduce unsaponifiables, to keep color and odor forming bodies to a minimum, and when necessary to concentrate the unsaturated acids. When you specify Drew Fatty Acids, you pay only for the fractions that are best for your product.**

*If you demand quality in your product, always insist on Drew Fatty Acids. Write for complete reference book, "Drew Fatty Acids", or phone us.*

*TECHNICAL PRODUCTS DIVISION*

**E. F. DREW & CO., INC.**

**15 EAST 26th STREET, NEW YORK 10, N. Y.**

**CHICAGO PHILADELPHIA BOSTON**

**DREW PRODUCTS**




# CITIES SERVICE gives *protected* service

— with drums guarded by **Tri-Sure** Closures

CITIES SERVICE refines the choicest crudes by the exclusive Heart-Cut Process to produce Koolmotor Oil. And Koolmotor drums are sealed with Tri-Sure Closures*—to give quality *protection* to quality processing.

Cities Service uses Tri-Sure Closures to safeguard its oils and greases for the same reason that other leading shippers place their faith in this *proven protection*: the Tri-Sure Flange, Plug and Seal eliminate all danger of leakage, pilferage and substitution. Give *your* drums Tri-Sure protection, and give your customers *proof* that you deliver full *quantity* and *quality* every time.

When you order drums, include the specification that always pays: *"equipped with Tri-Sure Closures."*

Tri-Sure
CLOSURES

*The "Tri-Sure" Trademark is a mark of reliability backed by 29 years serving industry. It tells your customers that genuine Tri-Sure Flanges (inserted with genuine Tri-Sure dies), Plugs and Seals have been used.

**AMERICAN FLANGE & MANUFACTURING CO. INC., 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.**

**Tri-Sure Products Limited, St. Catharines, Ontario, Canada**

**HEADQUARTERS FOR AIR HANDLING AND CONDITIONING EQUIPMENT**

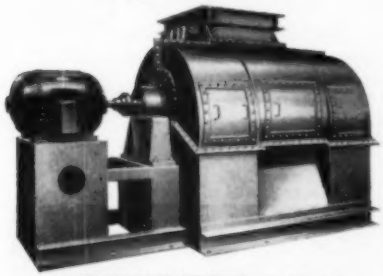
*. . . . to meet all types of industrial, power plant, commercial and public building requirements.*

# CLARAGE

## The Sign of Resourceful Engineering and Economical Performance



**INDUSTRIAL FANS**—for blowing or exhausting. Large range of capacity sizes—suitable for many applications.



**MECHANICAL DRAFT FANS**—both forced and induced draft. Heavy-duty construction for continuous operation at peak loads.



**CAST IRON FANS**—for industrial services. Unique construction assures extra long life when handling corrosive gases.

**What you're looking for in air handling and air conditioning you are likely to find at Clarage Fan . . .** highly efficient, dependable equipment — job engineered to your particular needs . . .

**It's nearly 40 years since we started building fans, blowers and allied products.** We have had ample time to temper research with experience, engineering with sound practice, manufacturing to actual operating in-the-field demands . . . .

**You can profit by dealing with Clarage.** We have an established reputation for getting things done right . . . . As evidence of what we mean, 97 of the 100 largest American corporations are users of Clarage fan equipment. Need we say more?

**CLARAGE FAN COMPANY**

**637 PORTER ST., KALAMAZOO, MICH.**

*SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES*

***IN CANADA:*** 4285 Richelieu St., Montreal
Canada Fans, Ltd.

**You Can Rely on Clarage**



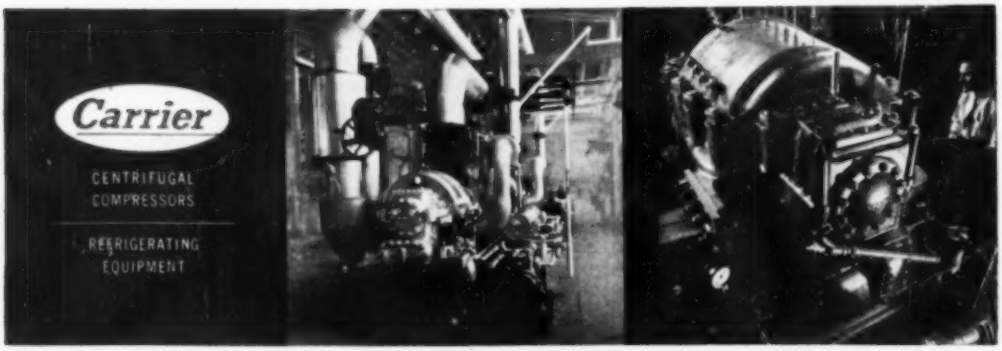
# Is there a gas we haven't met?

Our Carrier Centrifugal Compressors have compressed more different gases on the job than those of any other manufacturer. We think experience like that is important to you.

**Maybe you work with butane or propane. Ethylene, methylene chloride, ethane or chlorine. Air, oxygen, sulphur dioxide or hydrogen sulphide. All of these and many more have been used in our Centrifugal Compressors at some time or other during the past thirty years. So there's a lot of experience for you to draw upon when you call on Carrier.**

Carrier Centrifugal Compressors are available in standard designs from 2000 to 40,000 cfm, with three to seven wheels. In most cases they need no individual engineering. And they're built from standard, pretested components — you're sure of good performance right from the start.

There's a lot more to our Centrifugal Compressor story, of course. Why not consult the Carrier office nearest you? Or write Carrier Corporation, Syracuse 1, New York, for the catalog, "Centrifugal Compressors for Industry."




Carrier has built more multi-stage Centrifugal Compressors than any other manufacturer. Here is one of them (left) on the job at a petroleum company. Skilled workmanship, precision inspections (right) and grueling tests make Carrier Centrifugal Compressors the most dependable you can buy.



Walworth manufactures a *complete line* of Gate, Globe, Angle, Check, and Lubricated Plug Valves, made of Stainless Steel, Steel, Iron, Bronze, and Special Alloys in a wide range of sizes and temperature-pressure ratings.

Fittings of steel, iron, and bronze are also manufactured in all conventional types and sizes.

**WALWORTH**

**valves and fittings**

**60 East 42nd Street, New York 17, N. Y.**

Distributors in principal centers throughout the world

## Before You Buy . . . Consider Micro-Klean

When it comes to clarification, Cuno MICRO-KLEAN can handle a wide range of micronic filtration jobs just as satisfactorily as larger, more expensive filtering systems.

A MICRO-KLEAN is a *simple, inexpensive* unit, economical to install and operate. First cost is low. Maintenance cost is low.

It is *efficient* because it works by a positive mechanical principle —the only micronic filter to do so.

It is *economical* because of its greater dirt-holding capacity which means fewer cartridge changes. Thus, larger batches can be handled with each set of cartridges.

This greater capacity results from maximum porosity (85-90%) and exclusive "graded density in depth." Thousands of tiny fibres are carefully distributed through the structure to form interstices into which the solids are trapped.

The cartridge gets its strength from resinous impregnation and polymerization.

### Easy Replacement

Simply remove cover . . . lift out old cartridge . . . drop in new. Minimum of mess or bother.

GUARANTEED to remove 100% of all solids for which it is rated plus a large percentage down to 1 micron. Cartridge densities: 10, 25, 50 microns. Capacities: a few to over 800 gpm.

It is the lowest-cost device you can use to solve a wide range of micronic filtration problems.

Cuno Engineering Corporation
Dept. 104D, South Vine Street, Meriden, Conn.

Please send information on Cuno MICRO-KLEAN for following service.....

.....

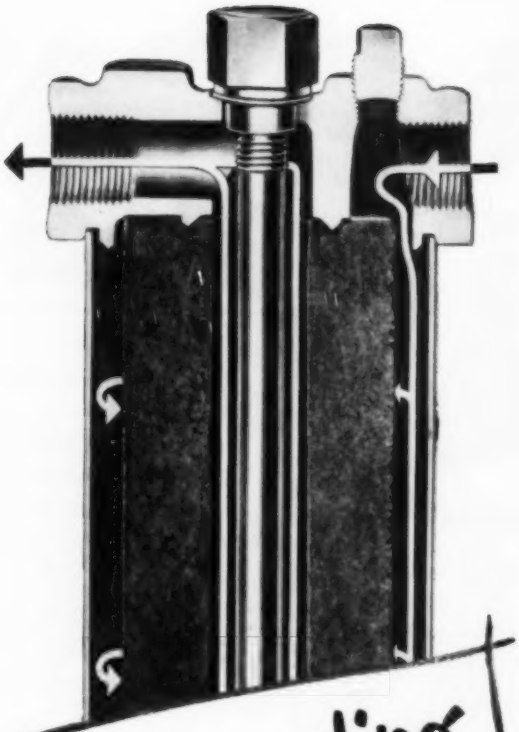
Name.....Title.....

Company.....

Address.....

City.....Zone....State.....

*Please attach to business letterhead*



# No Channeling with this micronic filter

Won't shrink, won't swell. Won't harden, won't soften. Won't distort in any way. That's Cuno MICRO-KLEAN . . . the filter that outlasts any other replaceable-cartridge filter 2 to 1!

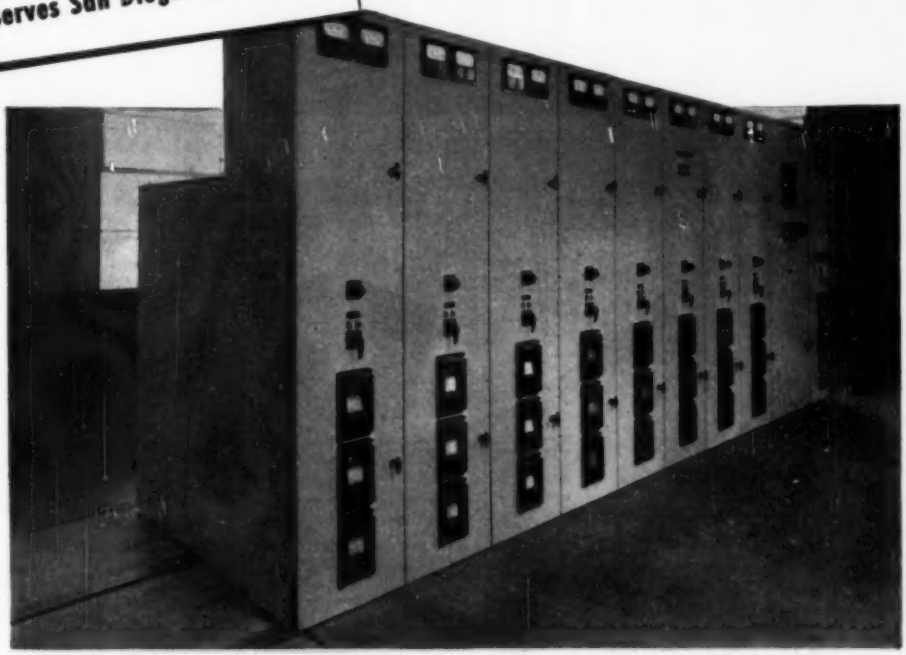
CUNO

*Fluid Conditioning*

**Removes More Sizes of Solids from More Kinds of Fluids**

**Strain** fuels, lubricants, process fluids, etc.—AUTO-KLEAN
**Filter** fuels, lubricants, process fluids, etc.—MICRO-KLEAN
**Clean** raw water, recirculating water, etc.—FLO-KLEAN

**Westinghouse Switchgear serves San Diego Marine Base**



This 2400-volt Metal-Clad Switchgear installation serves power and lighting circuits at the Marine Corps San Diego Recruit Depot.

## "...Its design eliminates operating hazards!"

This new Westinghouse Switchgear installation points up many advantages of replacing obsolete protective equipment with modern switchgear.

*"... Because its design eliminates operating hazards, the new equipment provides a big margin of safety over the old installation. Safety interlocks and complete isolation of live parts make switching, circuit testing, and breaker exchange as safe as turning on the lights.*

*"Lower over-all cost is anticipated also. Complete factory assembly and testing of the unit have resulted in substantially reduced installed cost . . . and its standardized design provides ample flexibility for low-cost expansion or conversion of the depot's power system."*

This is how Ets-Hokin & Galvan, Electrical Contractors on this job, sum up this Westinghouse Metal-Clad Switchgear. And they cover only a few of the benefits this modern equipment offers to *you*.

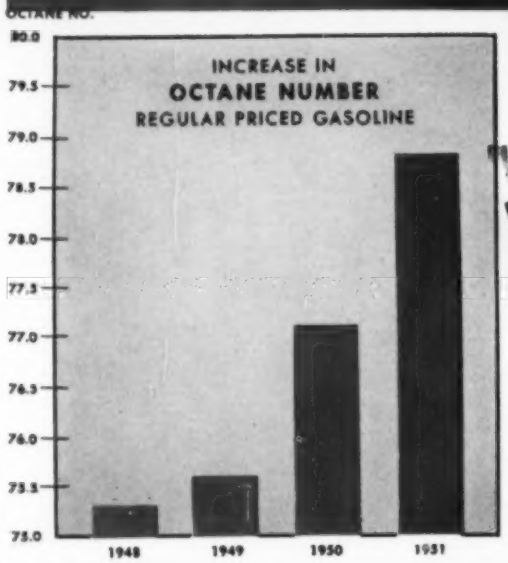
For complete information write for Booklet B-4016. Address: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-60757

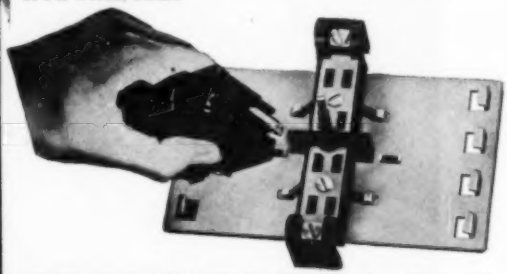
YOU CAN BE SURE... IF IT'S Westinghouse

**METAL-CLAD SWITCHGEAR**

# Life ...on the




**AS OCTANE NUMBERS HIT NEW HIGH** and demand for more powerful fuels increases, Cyanamid expands its catalyst output at Michigan City, Indiana. Here production of AERO-CAT® MS Synthetic Fluid Catalyst is being increased to a level sufficient for 800,000 barrels daily of refining capacity. This growth is a part of Cyanamid's planned program of expansion that began in 1942 with the establishment of a plant at Ft. Worth, Texas.



**NEW CIRCUIT BREAKER USES PLASTIC HOUSING** made of Cyanamid's BEETLE® Molding Compound. Engineers selected BEETLE because it provides the ease of the "Stab-lok" circuit breaker with arc resistance, good dielectric strength and high mechanical strength. This is an example of how Cyanamid creates new opportunities for industrial designers by providing materials with unusual combinations of properties.



**FOAMITE* FIREFOAM FIGHTS FIRE.** A great deal of destruction by fire is avoided by the use of Foamite fire extinguishers to blanket flames with a froth of carbon dioxide and aluminum hydroxide. Aluminum sulfate is one of the important chemicals which react to form this fire-snuffing foam. Produced by Cyanamid, aluminum sulfate meets manufacturers' highest standards for uniformity, quality and purity needed in this critical application as well as in other industrial uses.

*Registered trade mark of American-La France-Foamite Corp.

# Chemical Newsfront

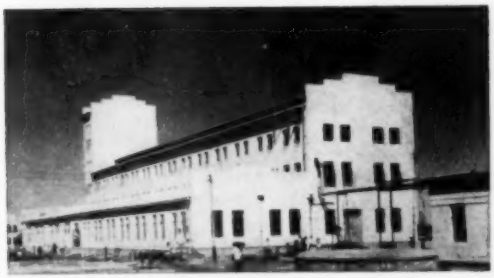
## NEW PRODUCT NEWS

**ACRYLAMIDE** $CH_2=CHCONH_2$

**N-tert-BUTYLACRYLAMIDE** $CH_2=CHCONHC(CH_3)_3$

**N,N'-METHYLENEBISACRYLAMIDE** $(CH_2=CHCONH)_2CH_2$

These new crystalline monomers are available in trial-lot quantities. They are reactive monomers having long shelf life and should be useful for applications requiring a polymer with additional functional groups. Possible fields of application: synthetic fibers, surface coatings, textile and paper finishes, and ion-exchange resins.



**INDIA'S FIRST DYESTUFFS AND PHARMACEUTICAL PLANT** opens at Bulsar. Built with technical and engineering assistance from American Cyanamid, this new plant, Atul Products Ltd., was described by Prime Minister Nehru as "one of the major construction works of New India." The $3,500,000 plant will be managed entirely by Indian engineers and scientists. It will produce a major portion of India's requirements of azo and sulfur dyes, as well as aureomycin, sulfa drugs and folic acid.


American Cyanamid Company CE, 6-52
30 Rockefeller Plaza, New York 20, N. Y.

Please send literature or further data on the items checked:

- ... AEROCAT MS Catalyst
- ... BEETLE Molding Compound
- ... Crystalline Monomers

Name ..... Position .....

Company .....

Address .....

City ..... State .....

In Canada: North American Cyanamid Limited, Toronto and Montreal

AMERICAN Cyanamid COMPANY

30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.



ON TIME...

CATALYTIC CONSTRUCTION 100%

Catalytic delivers on time and within the budget. Our blanket service in the petroleum and chemical fields covers every detail from the preliminary research to the finished plant.

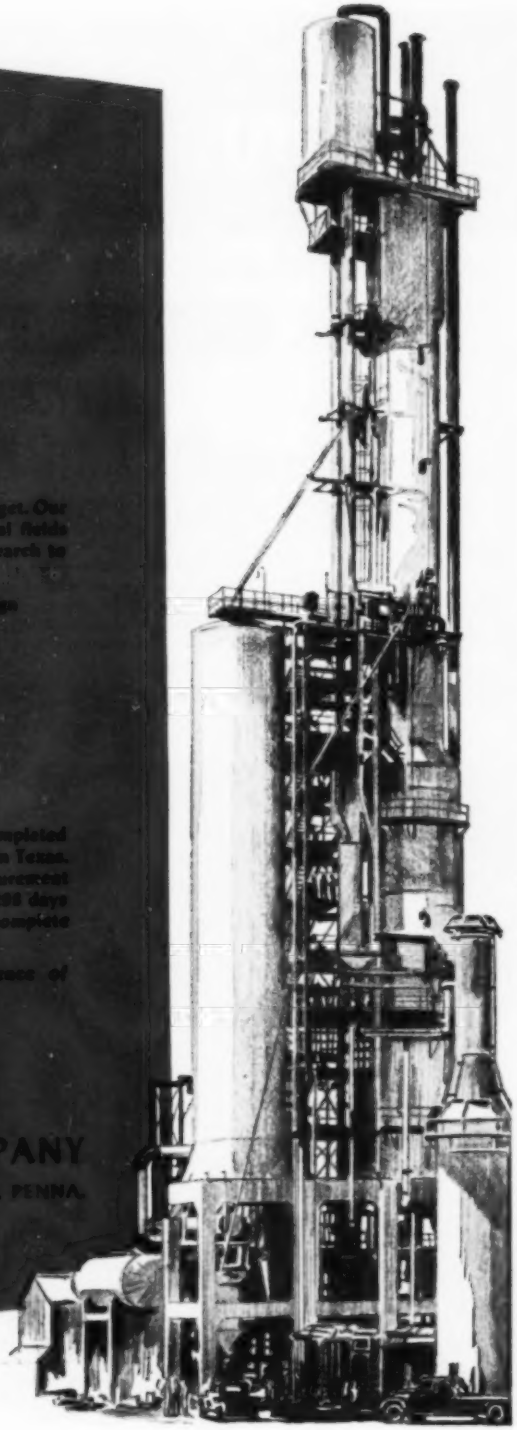
Research & Development
Pilot Plant Investigations
Economic Studies
Process Design
Engineering
Procurement
Construction
Plant Operation

Revamp of Existing Facilities
Plant Maintenance

Illustrated here is a cat-cracker recently completed for The Shamrock Oil and Gas Corporation in Texas. Including process design, engineering, procurement and construction—this unit went on stream 298 days after the contract was signed. Catalytic complete service 100% all the way.

You will find Catalytic's practical experience of value—beyond price.

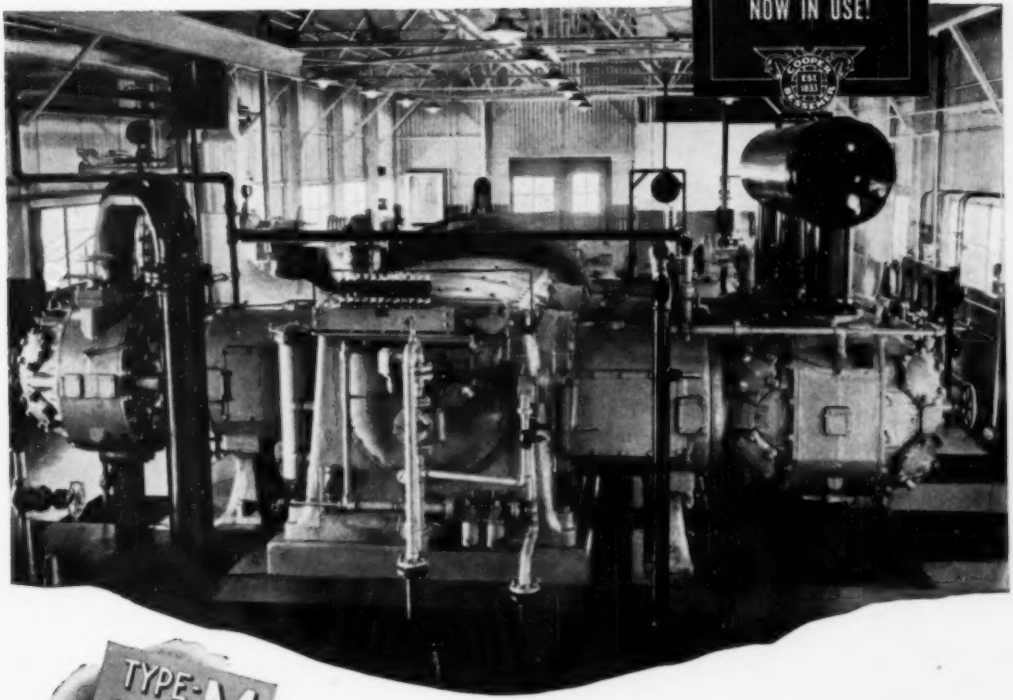
CATALYTIC
CONSTRUCTION COMPANY
1528 WALNUT STREET • PHILADELPHIA 2, PENNA.



# Cooper-Bessemer Compressors

## *Thousands speak louder than words!*

Over 6 million Cooper-Bessemer Compressor Horsepower NOW IN USE!






COOPER-BESSEMER Compressors of the most modern types, such as the space-saving unit shown above, today total millions of horsepower. You'll find these efficient compressors in all kinds of service.

Get all the facts on the latest Cooper-Bessemers. They are built for any type drive in sizes up to 5,000 horsepower, are backed by years of compressor-building experience.

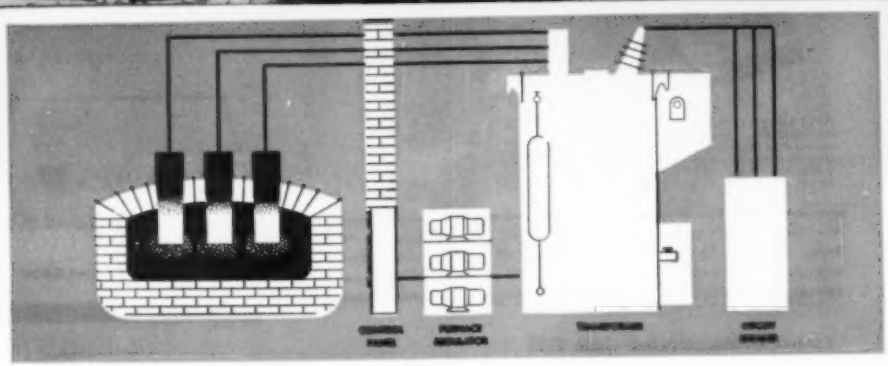
Send for your copy of this new bulletin covering the features, capacities, dimensions, weight, etc. of the Cooper-Bessemer power-driven Type M compressors, 200 to 1,000 hp. Other bulletins covering still larger sizes are also yours for the asking.

*The* **Cooper-Bessemer** *Corporation*

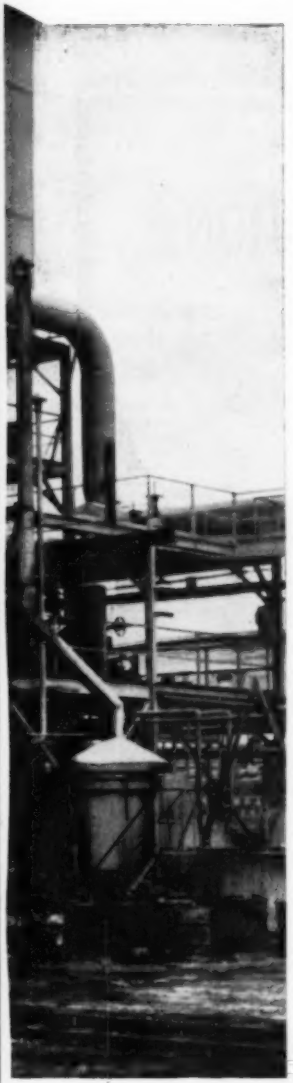
MOUNT VERNON, OHIO — GROVE CITY, PENNA.

New York Washington, D. C. Bradford, Pa. San Francisco Houston, Dallas, Greggton, Pampa and Odessa, Texas Seattle Tulsa Shreveport St. Louis Los Angeles Chicago Caracas, Venezuela Cooper-Bessemer of Canada, Ltd., Halifax, Nova Scotia Gloucester, Mass. New Orleans, La.

***They did what you can do to produce more***



# How the right Arc Furnace Equipment keeps costs down



Here's a case where a relatively small plant is one of the industry's lowest cost producers. It's the Virginia-Carolina Chemical Corporation's new electric furnace operation at Charleston, S. C., for the production of phosphorus.

### Power efficiency is 10% above normal

The biggest operating cost item is electric power (30 to 35% of total operating costs) so they planned the electrical system carefully and had Westinghouse help. First they designed for an unusually high operating voltage. This increased the efficiency 10% and also boosted furnace capacity. In effect, the high voltage lengthens the *reaction zone* in the furnace and thus increases production per kwhr.

### Rototrol runs furnace automatically

The furnace operation is controlled automatically by Westinghouse Rototrol®. It maintains the desired operating conditions by continuously moving the carbon electrodes up and down within the boiling charge. When any electrical disturbance occurs, Rototrol smoothly restores proper conditions without overshooting.

### System designed for high power factor

Smart planning also resulted in a high power factor for the unit and this further reduced power bills. The whole electrical system is highly dependable because of the experience Westinghouse brings to furnace equipment design. More Westinghouse arc furnace equipment is in use than all other makes combined.

### Call Westinghouse on your next project

This project is typical of the engineering assistance and equipment Westinghouse applies to chemical processes. When your next project comes up, call Westinghouse *early* in the planning stage.

***FREE BOOK ON ARC FURNACE EQUIPMENT***

If you're interested in arc furnace production, write now for this free book "Westinghouse Equipment for Electric Arc Furnaces", B-4695. It tells how you can increase output, get more dependable production. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94886



YOU CAN BE SURE...IF IT'S

**Westinghouse**

EQUIPMENT FOR CHEMICAL PROCESSES

*Combined for Service and Savings:*

# AUTOMATIC CONTROL

# *and* INSTRUMENTATION

## by HAGAN

Hagan Engineers have developed automatic control equipment and instruments which can be assembled into coordinated systems designed to meet your particular requirements. For example:

**HAGAN AIR-OPERATED AUTOMATIC CONTROL EQUIPMENT** includes pressure measuring and control units which may be combined into automatic control systems for process industries, metallurgical furnaces and steam power plants.

**HAGAN THRUSTORQ** is designed to measure forces and transmit a proportional signal to actuate a recording or indicating instrument, or an automatic control system. Typical applications include: automatic batch weighing, rocket thrust measurement, dynamometer testing of electric motors and internal combustion engines.

**HAGAN RING BALANCE FLOW METERS** are the most versatile meters available. Hagan Meters indicate, record, and integrate one or two flow rates. Standard modifications provide for pressure and temperature compensation. Ring assemblies are available to measure pressure differentials from 20" to 140" WC at static pressures up to 15,000 psig, and from 40" to 420" WC at static pressures to 2000 psig.

**WRITE, WIRE or PHONE** today for information about how Hagan Engineers can help you solve your industrial control and instrumentation problems.

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HAGAN BUILDING
PITTSBURGH 30, PENNSYLVANIA

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

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TRENTON, N.J.

COST NOTE:
Setter tiles fortified with ALCOA Alumina last at least twice as long!

Stangl Pottery, manufacturers of fine dinnerware and art ware, proved that setter tiles fortified with ALCOA Alumina last at least twice as long as silicon carbide slabs.

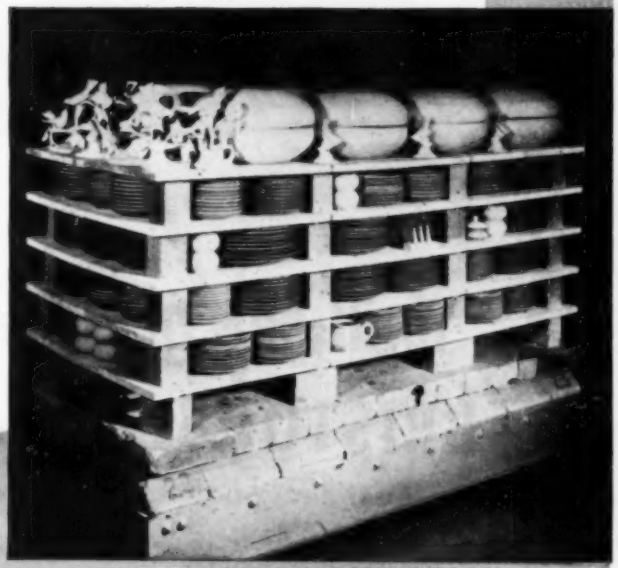
In a convincing test lasting more than a year, Stangl found that tiles manufactured by *Richard C. Remmey Son Company* (fortified with ALCOA Alumina) gave excellent service for at least twelve months, after surviving the initial fire. But ordinary slabs used in the same process failed in about three months, on the average.

The conclusion was clear to Stangl: To cut costs, use slabs and spacers fortified with ALCOA Alumina . . . and that is exactly what they are doing!

If you have high-temperature problems, why not take a cue from Stangl? Investigate the money-saving features of porcelains, refractories and other high-heat ceramics fortified with ALCOA Alumina. It's a sure way to reduce down-time . . . maintain higher operating temperatures over longer periods . . . increase load-bearing strength.

Let us discuss with you the value of ALCOA Alumina in the refractories you use or make. We may give you some interesting facts.

Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 602-F Gulf Building, Pittsburgh 19, Pa.



Biscuit car at Stangl using ALCOA Alumina-fortified slabs and deck spacers. Normal firing schedule is two hours at C/3. Tunnel kiln 111 ft. long.

Alcoa Chemicals

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***Continuous-balancing electronic recorders***

A high-speed, accurate electronic brain to measure, record, and control d-c voltage, d-c current, resistance, capacitance—or any variable that can be converted into those quantities.

The continuous-balancing circuit responds to minute changes *instantly*.

Available as a self-balancing bridge or potentiometer, the Dynamaster is a versatile, dependable, trouble-free measuring instrument.

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**AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS**

# CHECK THESE ✓ practical features

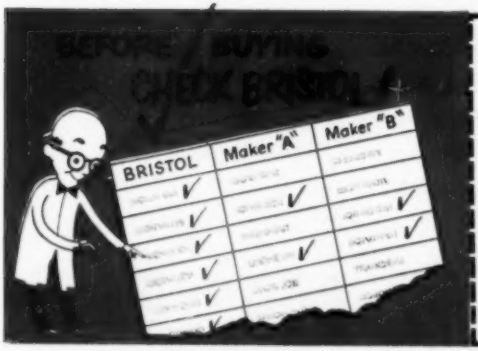
Simple design for long, trouble-free operation
Little or no maintenance
Electronic component uses vacuum tubes
available from any radio supply house
Full-scale pen travel in 7, 3, or ⅔ seconds
Chart speeds from ¾ in. per hour
to 7200 in. per hour
Multipoint recorders up to 16 points
Same amplifier used on all Dynamaster models
. . . can be removed and replaced with
nothing but a screwdriver
Periodic automatic standardization
on potentiometer models
Exceptionally unaffected by stray currents
(1000 to 1 discrimination)
Practically immune to vibration or shock

**FOR MORE INFORMATION** *on how Dynamaster can solve your measurement problems, use the coupon to send for Catalog No. P1245.*



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### *are using Dynamasters*

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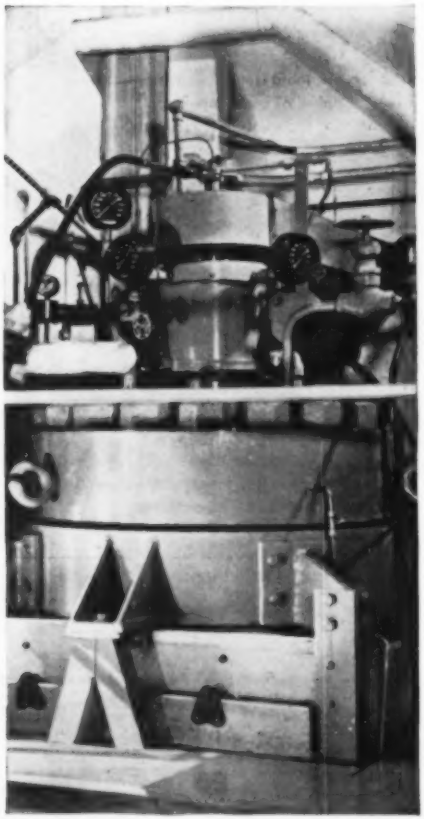
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ADDRESS _____

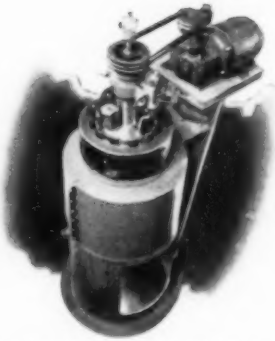
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*5 gal. stainless steel, electrically-heated autoclave for 2000 psi working pressure.*

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- Patented stuffing box design for trouble-free service.
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# Complete Seating Contact!

***You know you've got it with . . .***

# CHAPMAN

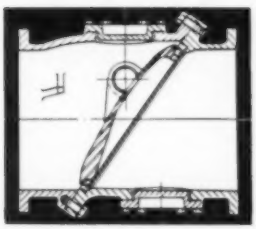
## *Exclusive* TILTING DISC *Check Valve*

Nothing can "unseat" the disc-ring of this valve from its *drop-tight* contact with the body-ring . . . because clearance at the hinge-pins means that this contact is *complete.* There is no sliding action, consequently no wear, no leakage. And the pivoted disc is cushioned to an easy, silent closing . . . without slam . . . in installations that don't have unusual piping arrangements.

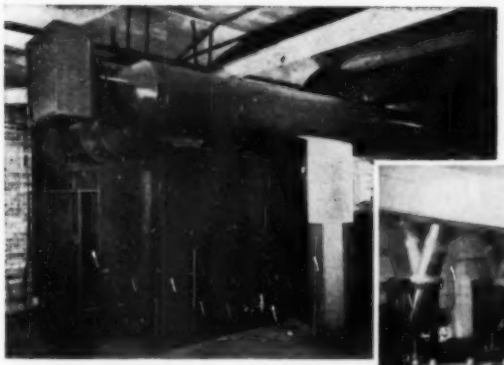
What's more, hydraulic laboratory tests at a top engineering school prove that the specially designed disc and streamlined valve-body reduce head loss as much as 80% under conventional swing-type check valves. See the graphs of these tests . . . and illustrations of the unique construction features of Chapman Tilting Disc Check Valves . . . in Catalog No. 30 (yours for the asking). *Write.*

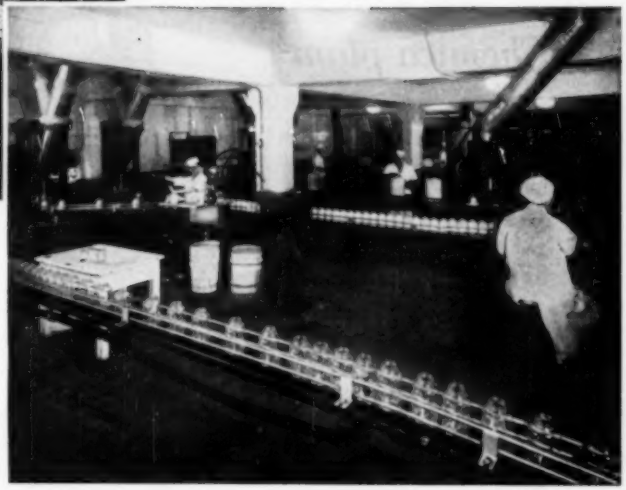



**THE CHAPMAN VALVE MFG. CO.**
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Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.





The Lectrodryer holds this filling room below 50% relative humidity, so the malted milk powder is kept DRY.

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Horlick's malted milk powder flows freely from the dispenser, because it was packaged in a DRY atmosphere. Regardless of outside weather conditions in Racine, Wisconsin—any day in the year—this filling room has "winter-weather DRY-ness". A Lectrodryer® keeps it that way.

Supply DRY air to processing equipment, workrooms and storage areas and you speed production, while also preserving product quality. That's the experience of thousands of plants all over the world, in dozens of industries. Lectrodryers do that DRYing.

The book, "Because Moisture Isn't Pink" describing many of these installations, may be your key to ways of increasing your production. For a free copy, write Pittsburgh Lectrodryer Corporation, 303 32nd Street, Pittsburgh 30, Pennsylvania. Ask for Bulletin 216.

In England: Birtec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birtec, Limited, 51 Parramatta Road, Glebe, Sydney.
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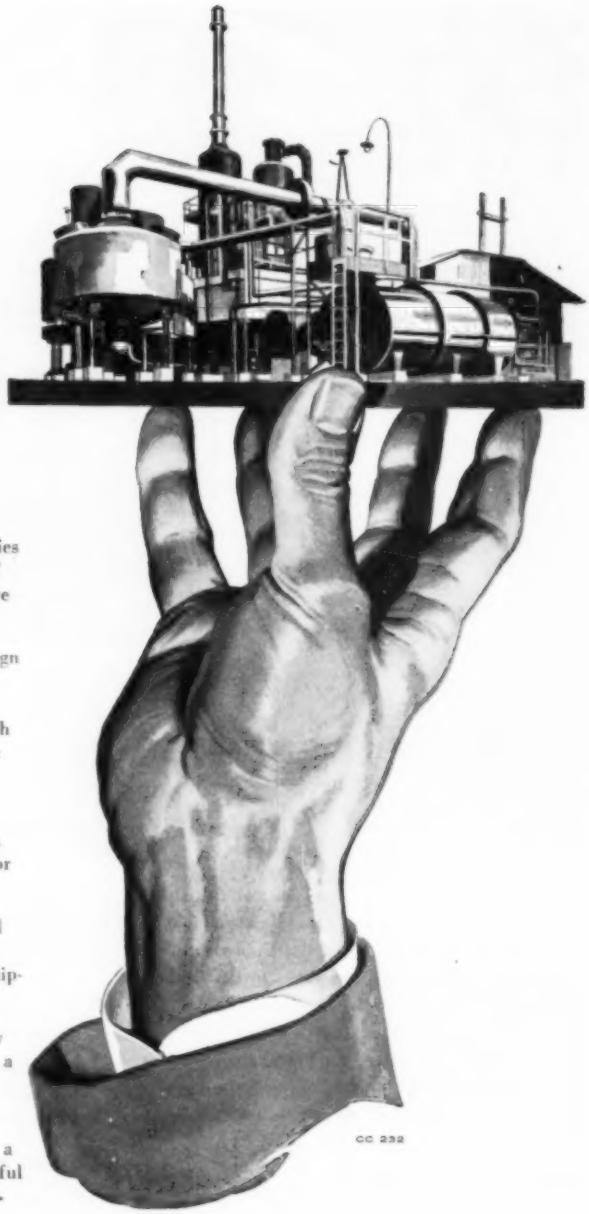
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*No matter how you look at a Chemico plant*

**it's a profitable investment**



If you are thinking of expanding present facilities or erecting a new plant for the manufacture of heavy chemicals, look into Chemico's all-inclusive service.

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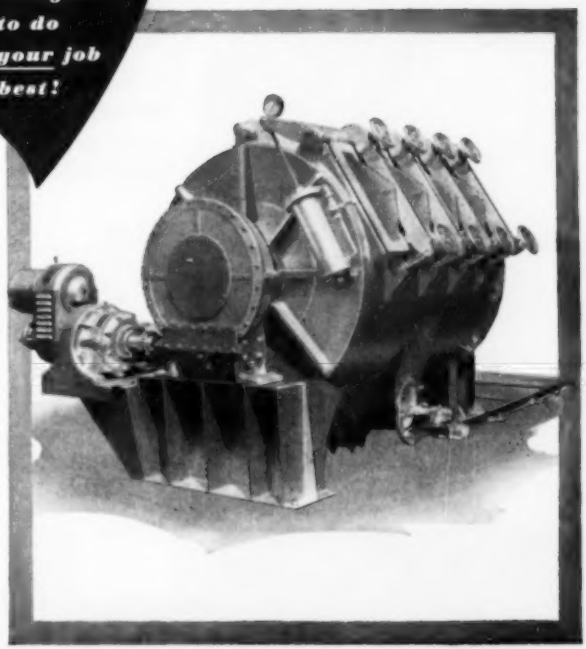
TECHNICAL REPRESENTATIVES: IN EUROPE—CYANAMID PRODUCTS LTD., LONDON; IN CANADA—CHEMICAL CONSTRUCTION (INTER-AMERICAN) LTD., TORONTO; IN SOUTHERN AFRICA—SOUTH AFRICA CYANAMID (PTY) LTD., JOHANNESBURG

*Chemico plants are profitable investments*

*See*
*General American for*
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# You never have to open a Conkey Rotary Leaf Pressure Filter during regular operating cycle

*Designed to do your job best!*



Because slow rotation of filter leaves in the slurry prevents separation (settling out) of solids, and insures formation of a uniform cake structure of even thickness and high washing efficiency, with positive cake discharge, you never need open a Conkey Rotary Leaf Pressure Filter during regular operation for cake discharge or other cyclic requirement. Thus very considerable savings in filter cloth and labor are effected.

Volatile or dangerous liquids may be handled safely. Operating cycles are economical. Cake building, cake washing and dewatering are independent and consonant with optimum requirements of each filtration.

Filter leaves—sectored and easily removable—permit filter to be dressed with cotton fabric, while quick-opening ports permit replacement of any sector requiring re-dressing. Cloth replacement requirements can be readily and positively identified through filtrate sample cocks or observation tubes. For complete data relative to various applications of this superior filter, write for technical bulletin No. 105.

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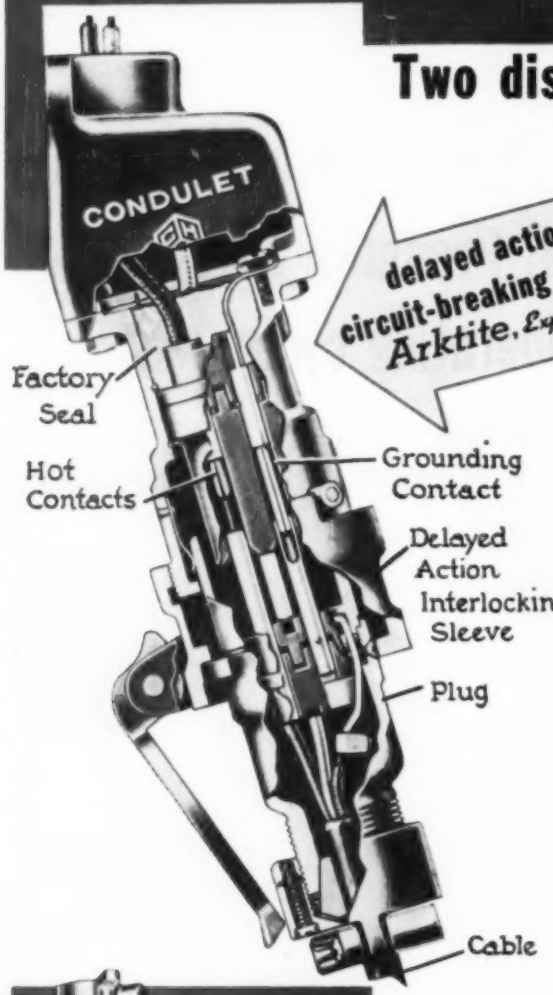
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# CROUSE-HINDS PLUGS and

## Two distinct types in a wide hazardous area




**delayed action and circuit-breaking Type CES Arktite, *Explosion-Proof***

Both types have been service tested through the years for continued safe and dependable use. Both are approved by Underwriters' Laboratories, Inc. . . . Type CES for atmospheres containing explosive gases or vapors and Type FSQ for either explosive or dusty atmospheres. You can rely on both types for the safe connection of portable electrical equipment in such hazardous locations.

### Type CES

**1.** Crouse-Hinds famous *Arktite* design . . . circuit-breaking at full load . . . no disconnect switch required.

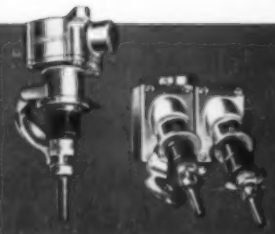
**2.** Plugs can be used in non-explosion-proof *Arktite* receptacles, permitting the use of special explosion-proof portable equipment and tools in non-hazardous locations. However, non-hazardous equipment cannot be used in hazardous areas because Type CES Explosion-Proof Receptacles will not accept the regular *Arktite* plugs.

**3.** Simple delayed action feature . . . insert plug, twist . . . push. Contacts make and break in tight explosion-proof chamber without enough oxygen to maintain the arc.

**4.** Pigtails in splice box . . . factory sealed to contain any explosion.

**5.** Up to 30-Amp., 460-Volt, A. C.; 60-Amp., 230-Volt, A. C., single and 3-phase.

**6.** Explosion-proof.



Type CPS 15-Ampere — Type CPS 15-Ampere — Type EHS Flush Mounted Up to 30-Ampere — Type CPS Flush Mounted Up to 30-Ampere

← Other explosion-proof *Arktite* receptacles similar to CES.

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# *Explosion-Proof and Dust-Tight* RECEPTACLES

## range of sizes to meet your requirements




**Type FSQ**

**1.** Has built-in interlocked disconnect switch . . . no separate disconnect required.

**2.** Simple, sure dead front action . . . insert plug and twist to turn on switch . . . twist to withdraw plug. Twisting operates built-in switch. Plugs cannot be inserted or withdrawn with switch "ON".

**3.** The threaded cover can only be removed when the switch is "OFF" and the switch cannot be turned "ON" until the cover is on and locked in position by a special screw.

**4.** Up to 30-Amp., 460-Volt, A. C. single and 3-phase; or 250-Volt, D. C.

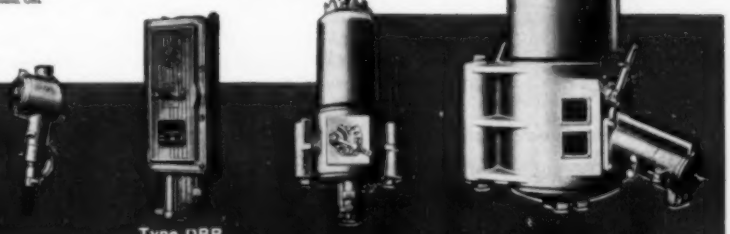
**5.** Explosion-proof and dust-tight.

Look for the complete listings in your Condulet Catalog, or send for full information.

**CROUSE-HINDS COMPANY**
Syracuse 1, N. Y.

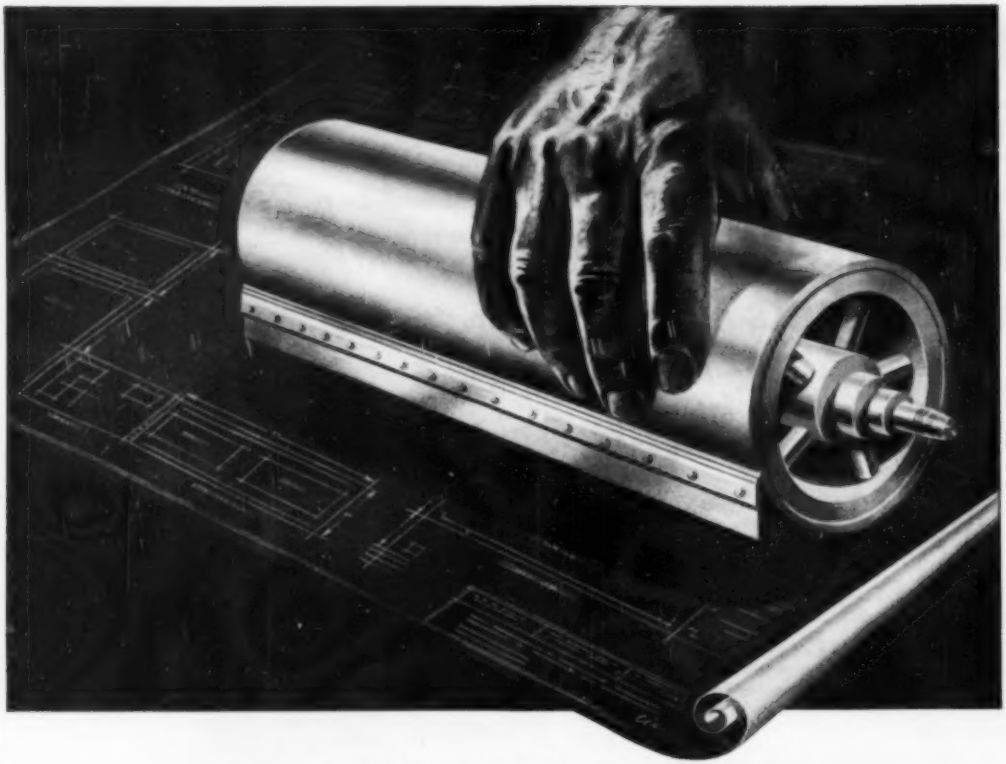
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Other explosion-proof and dust-tight receptacles with interlocked switches or circuit breakers. →



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# How to Plan Higher Output with Faster, Safer Drying

To increase production, a large eastern chemical manufacturer installed a 60" diameter Lukenweld Jacketed Steel Roll to replace one of conventional type, identical in size. When operated at the same pressure as the one it replaced, the new roll increased production 33%—proof that under identical pressures Lukenweld Jacketed Steel Rolls are better heat transfer units. When pressure in the new roll was increased, *production* jumped 67%.




Whether drying, cooling or flaking, production increases like these may be within your reach, too, with Lukenweld Jacketed Steel Rolls. Featuring assured safety through use of high-strength rolled steel plate, Lukenweld rolls permit faster drying operation at pressures as high as 350 psi. By restricting steam to a shallow annular passage Lukenweld rolls reach operating temperatures faster . . . reflect pressure variations quicker. In addition, Lukenweld rolls offer the advantages of reduced installation and maintenance costs, more flexible operation.

For information on flaking or drying for the chemical field, write: Lukenweld, Division of Lukens Steel Company, 400 Lukens Building, Coatesville, Pa.

*Improved machinery for improved processes through engineering*

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A DIVISION OF LUKENS STEEL COMPANY

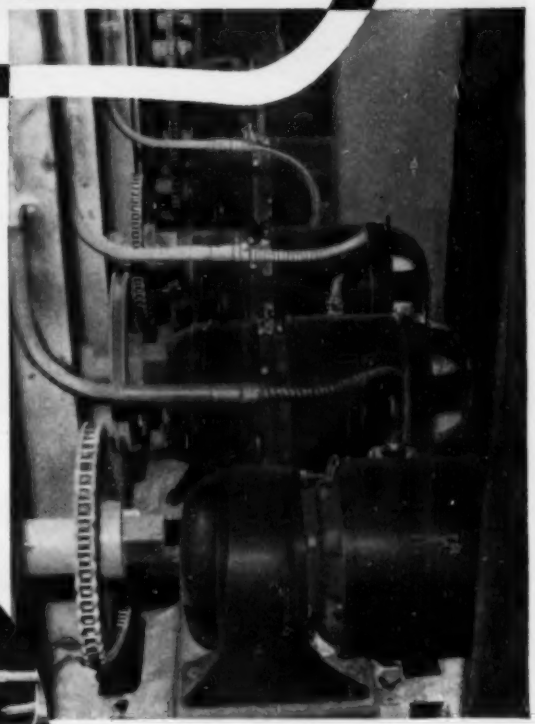
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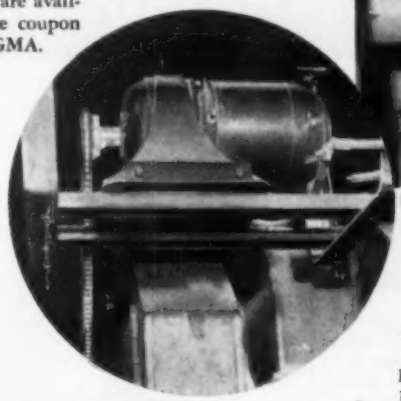
# engineered for tough jobs ideal for ANY job

Here is a battery of Foote Bros.-Louis Allis Gearmotors at work for the International Milling Company in Detroit. Enduring heavy loads under excessive dust conditions, these units are providing positive, uniform power, day in and day out, under rugged service.

These Gearmotors incorporate Duti-Rated Gears with file hard surfaces and resilient cores, assuring maximum strength in minimum size. The cast iron housings give rigidity, and the large oil reservoir with splash lubrication means continuous, trouble-free operation.

Foote Bros.-Louis Allis Gearmotors are available in single, double and triple reductions to provide output speeds of 780 down to 7.5 r.p.m. Capacities from 1 h.p. through 150 h.p. Open drip-proof, splash-proof, enclosed and explosion-proof motors are available. Mail the coupon for Bulletin GMA.





Foote Bros.-Louis Allis Gearmotors installed at the International Milling Company, Detroit, Michigan.

FOOTE BROS.

*Better Power Transmission Through Better Gears*

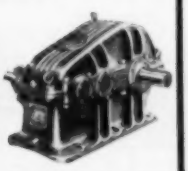
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## TAPER-LOCK

*–The Sheave that always runs true!*

The Taper-Lock bushing seats evenly along the entire length of the hub. It is self-seating. There is no collar—no protruding part—no flange to prevent uniform compression.

With full contact, Taper-Lock sheaves run true. Made of finest grade of close-grained semi-steel, cast in the Dodge foundry. Precision grooves have identical pitch diameters so that every belt can pull its share of the load.

Sheave and bushing mount as a unit—easy to align on the shaft. Grips the shaft like a shrunk-on fit. Flush hub means safety.

THERE IS ONLY ONE TAPER-LOCK (a patented product of Dodge). Available from distributors' stocks in a complete range of sizes in A-B combination, B, C and D grooves. Also ask your distributors for Dodge Sealed-Life V-Belts. WRITE for complete data.

**DODGE MANUFACTURING CORPORATION, 200 Union St., Mishawaka, Indiana**



**DODGE**

*of Mishawaka, Ind.*



**CALL THE TRANSMISSIONEER**

your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified phone book.

[redacted] FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, CHICAGO THRIFT-ETCHING CORPORATION, 1555 SHEFFIELD AVENUE, CHICAGO 22, ILLINOIS

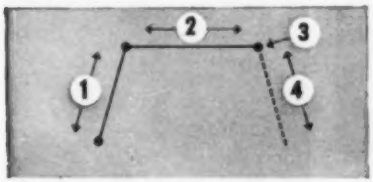
# If You're Batch-Cooking You Can Use This Inexpensive Control





Here is a recorder-controller planned especially for economically controlling processes like batch cooking. The Gotham Elapsed Time Recorder-Controller does the essential control jobs easily and accurately. First of all, it brings the batch up to maximum holding temperature fast. It holds the batch at that temperature for a predetermined period. It shuts down the process at the end of the cooking period. Those are its three standard functions. Automatic venting or cooling functions can be added. Also available with a pressure, instead of temperature, system.

Write for full information about the Elapsed Time Recorder-Controller and other Gotham Controllers. They're in Catalog 500.




## This Is What the Gotham Elapsed Time Recorder-Controller Does

1. Brings controlled variable (temperature or pressure) up to maximum fast.
2. Holds variable at maximum for predetermined period.
3. Shuts down process.
4. Automatic venting or cooling can be added.

## Gotham Elapsed Time Recorder-Controller

### SPECIFICATIONS

**CHART SIZE:** 12"

**CASE:** Standard - black crinkle; smooth black or white may be obtained.

**ACTUATION:** Vapor, Gas or Mercury for temperature. Pressure elements available.

**CHART DRIVE:** Spring wound or synchronous motor.

**CONTROL SYSTEM:** Pilot relay with adjustable sensitivity for 0 to 30% throttling band is standard, two position or 100% throttling band available.

**HOLDING PERIOD:** Standard 0 to 3 hrs. Other periods available.

*Keep Everything Under Control With Gotham*

GOTHAM INSTRUMENTS

Division of AMERICAN MACHINE AND METALS, INC.

Dept. 9, 233 Broadway, New York 12, New York

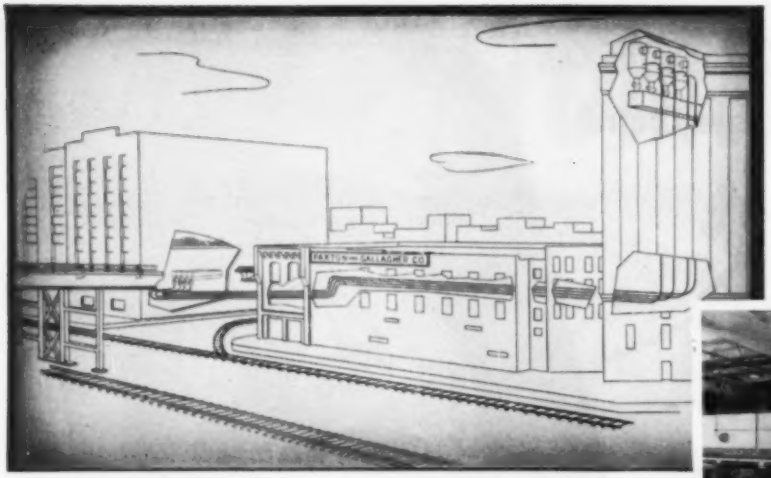


Diagram showing location of Dracco conveyor installation at Paxton and Gallagher Co., Omaha, Neb., which carries coffee from storage bins, over a rail siding and under a vehicle bridge, through three buildings and up to the receivers and roasters on the ninth floor of the final process building.

# *Imagine trying to do this* ANY OTHER WAY!

**THE CUSTOMER PROBLEM**—To improve the slow and costly method of handling bulk coffee beans over a route that included (1) a four-floor elevator drop to a siding, (2) a hundred-yard rail haul, and (3) a nine-floor elevator lift to final processing equipment. The work included two loading and two unloading operations.

**THE DRACCO ANSWER**—A Dracco Pneumatic Conveyor now transports the coffee *automatically* at 36 tons per hour! It is carried through a completely enclosed sanitary system directly from the storage floor to the final processing machines.

**THE RESULT**—Slow manual and mechanical materials handling was eliminated, plant capacity was substantially increased, and operating costs were reduced to a minimum.

This cost-saving materials handling installation is typical of the modern technique of handling dry bulk materials with Dracco Pneumatic Conveyors.

**DRACCO CORPORATION**

**Harvard Avenue and East 116th St. • Cleveland 5, Ohio**

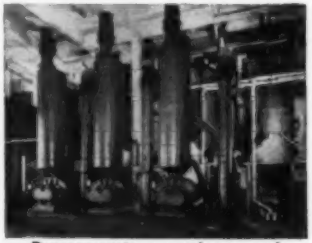
*Further information on the advantages of Dracco Pneumatic Conveyor as related to your materials handling problem may be had by contacting the nearest Dracco representative or Dept. C-6, Cleveland, Ohio.*



Surge hoppers receive coffee beans from blenders. Coffee is automatically fed from these hoppers into the conveyor system.



Trestle between buildings supporting conveyor pipes over rail siding and under vehicle bridge.



Dracco system receivers and vacuum pumps on the ninth floor of the final process building. Each of the pumps creates the vacuum used to transport 12 tons of coffee beans per hour.

**DRACCO** *Performance Proved*

**DUST CONTROL EQUIPMENT · PNEUMATIC CONVEYORS**

# How porous *do you want your* catalyst supports?

Norton catalyst supports come in two types:

**1. If your process calls for coated catalyst supports,** you get what you want from Norton medium-porosity spheres. They have a porosity of 30-35%, with a rough, open surface structure. This gives you maximum adherence of catalyst to surface.

**2. If you need supports for impregnation,** Norton high-porosity spheres are your choice. Their porosity is 42-47% with large, connected, internal pores uniformly dispersed throughout the support. This gives you maximum deposition of catalyst.

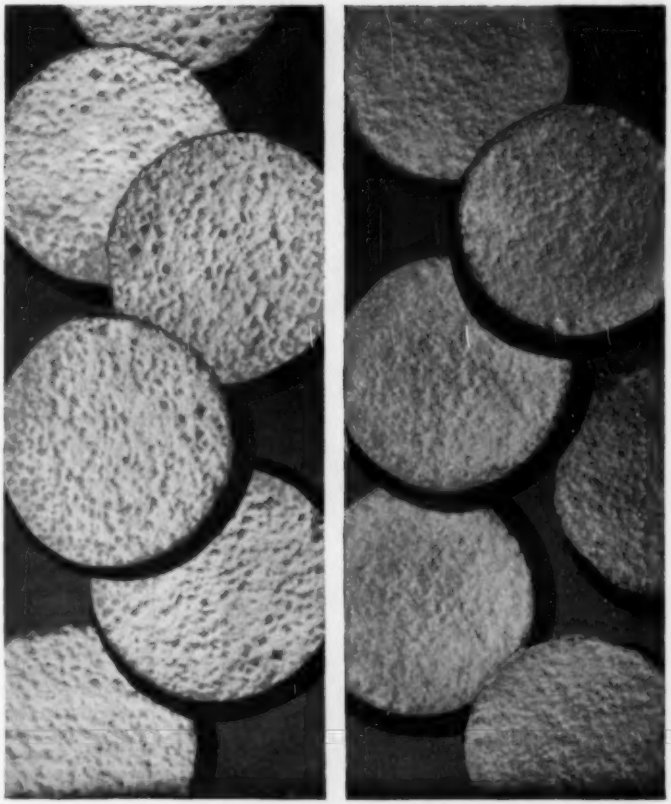
**You also have a choice of sizes and shapes.** Norton spheres are available in diameters of $\frac{1}{16}$" to 1". Other Norton catalyst supports, in ring and pellet form, available in diameters of $\frac{1}{8}$" to 2".

**A choice of materials, too.** Norton catalyst supports can be made from a variety of refractory materials, offering many different combinations of properties.

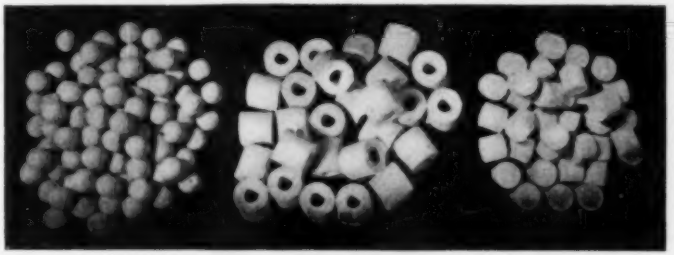
### *Test them in action*

You can easily prove, in your own plant, what Norton catalyst supports can do towards improving your production. Want to see samples? Contact your Norton representative or write direct to Norton Company, 503 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ont.

**NORTON HEAT EXCHANGE PEBBLES** also offer you worthwhile advantages, especially where alternating oxidizing and reducing atmospheres are met. They're made of ALUNDUM* electrically fused alumina (alumina content 95% to 99%). Nothing like them for static or moving heat exchange beds.



Greatly enlarged views of cross-sections of the two types of Norton catalyst support spheres. *Left: Norton High-Porosity Spheres* have connected pores throughout. *Right: Norton Medium-Porosity Spheres* have pores close to surface. You can also get Norton Low-Porosity Spheres if required.



Norton catalyst supports are made in sphere, ring, and pellet form.

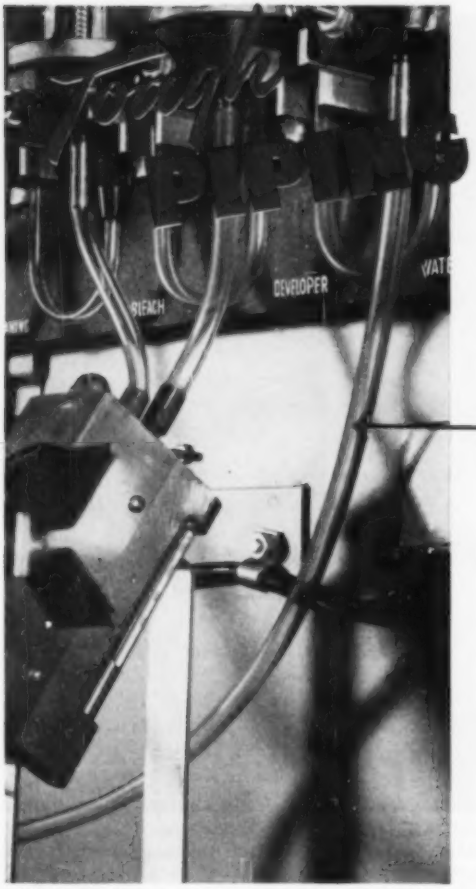
*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

NORTON

*Special REFRACTORIES*

*Making better products to make other products better*

NORTON COMPANY, WORCESTER 6, MASSACHUSETTS




**TYGON TUBING** — as used in an automatic picture taking machine. Here the clarity, flexibility, and resistance of TYGON to photographic chemicals has greatly increased service life, simplified operation, and minimized maintenance as compared to that obtained with rubber tubing.

# PROBLEMS

## EASILY SOLVED WITH

# TYGON TUBING

Every day, tough piping problems — big and small — are being solved with versatile, plastic TYGON TUBING. Designers and engineers, throughout industry, are finding TYGON the quick, easy, positive answer to tricky transmission jobs involving liquids, gases, or semi-solids.

TYGON Tubing not only resists acids, alkalies, oils, greases, certain solvents, and water — but is glass-clear and fully flexible. TYGON also is strong, smooth-surfaced, abrasion-resistant, light in weight, and non-oxidizing. Certain formulations are completely non-toxic.

TYGON's excellent chemical resistance permits its use with virtually any corrosive. Its clarity permits full solution visibility and control. Its flexibility permits the most intricate use without kinking. Its smooth surfaces give maximum flow, easy cleaning, and free draining. Its non-toxicity assures complete safety in food, beverage or medical applications.

TYGON Tubing is made in continuous lengths and a number of stock sizes ranging from ⅛" ID to 2" ID. There are six standard formulations available in clear or glossy black which exhibit a range of physical, electrical, and chemical properties. Braided jacket reinforcement of stainless steel, Saran, or cotton is available and suggested where high constant pressures are encountered.

Special compounds and sizes — including rigid tubing — to meet specific requirements can be made where volume warrants.

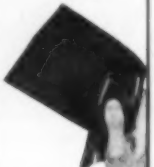
Write, today, for more information and technical assistance on the use of TYGON Tubing. Ask for Bulletin-77. Ask also about the other forms of versatile TYGON that can help you combat corrosion.

**TYGON PAINT**




quickly applied, fast drying protection against corrosive fumes and spillage.

**TYGON TANK LINING**



long lasting, heavy duty sheet TYGON to withstand virtually all chemicals.

**MOLDED TYGON**



accurate, durable parts and fittings of outstanding chemical resistance for all types of equipment.

**U. S. STONEWARE**
AKRON 9, OHIO

TYGON Flexible Plastic TUBING

403-C

PLASTICS AND SYNTHETICS DIVISION

# THE Chementator

Reg. U.S. Pat. Off.

*Prepared under the editorial direction of Joseph A. O'Connor, News Editor*

**For chemicals, a dazzling decade ahead**

Chemical output could rise as much as 75 percent, compared with an estimated 19 percent rise in industrial production, in the decade from 1951 to 1961. That's barring all-out war or a major economic crisis.

Synthetic fibers, for example, could double their market by 1961. Petrochemical manufacturers believe that by 1961 about 50 percent of all synthetic organics will be made from oil or its byproducts. Natural gas sales could double or triple within a decade. Light metals, such as aluminum, magnesium and titanium, will gain faster than old standbys like copper and iron.

**Wulff acetylene process goes commercial**

Wulff Process Co. has just entered into agreements with Lummus Co. of New York, the Fluor Corp. of Los Angeles and Girdler Corp. of Louisville authorizing these companies to design and construct plants using the Wulff process for making acetylene and ethylene.

The three engineering companies will get their profits from engineering design and construction work; they will pay no license fees. Wulff will get its profits from royalties paid by actual operators of the plants. At the outset, the three engineering firms can only offer the process to companies that will use the acetylene and ethylene to produce other chemicals.

Wulff has been running a pilot plant in Maywood, Calif., for 18 months, during the last nine of which the plant has been in continuous commercial production of acetylene. Wulff is currently expanding its Maywood plant to incorporate process improvements. And Wulff is also now ready to license the process.

The process uses natural gas, ethane, propane, butane or any liquefied petroleum gas mixture as feedstock, and produces low-cost acetylene. It can be used in plants making from 1 to 100 tons a day. The process can also be used to produce ethylene alone or for the simultaneous production of acetylene and ethylene. It wouldn't be surprising if Koppers were more than casually interested in the Wulff process.

**How soon the hydrogen bomb?**

The hydrogen bomb is now a virtual certainty. Despite qualms of some experts about what will happen when the first one is triggered off, work is being pushed.

Congress reportedly has been told that there "soon" will be a single bomb packing more explosive power than all the bombs dropped in World War II. The U.S. Air Force alone dropped more than 2.5 million tons of bombs in that war.

The new bomb reportedly will equal or surpass 100 atomic bombs in destructive power. A "good guess" is that the U.S. is "not too far away" from its hydrogen bomb goal. But Russia may be "as near or nearer."

**Only the beginning for Chemico's new process**

Watch for important new uses of the chemical refining process for metals that Chemical Construction Corp. has just unveiled (see *Chementator*, Sept. 1951, p. 112, and Nov. 1951, p. 106). At the outset the Chemico process will be used to slash the cost of recovering nickel, copper and cobalt.

But other possibilities abound. Not only can the process be used to get sintered manganese oxide from low-grade U.S. ores, but it might be used by the steel industry to extract manganese from blast furnace slag. One big steel company plans practical testing of the process in its own operations. Another, one of the largest, has sized up the economics of the process.

Using the new Chemico process, limited tests indicate, it might be possible to extract alumina from clay and to produce titanium dioxide, both at costs from half to one-third of present costs per ton. Pure iron powder might be extracted from taconite, eliminating the need for open hearth operations. The process could also be adapted to recovery of chromium as oxide.

Significantly, while little has been said about it, considerable work has been done by Chemical Construction and Sherritt Gordon in the latter's Ottawa pilot plant to develop a high-pressure high-temperature acid leach for uranium ores from Eldorado's new Beaver Lodge operation in Saskatchewan.

**Cobalt: tighter controls, higher goal**

A drive to boost total U.S. supply of cobalt to 21 million pounds a year by 1955 has been called for by DPA. The increase would include imports and production in this country. This goal is 11 million pounds higher than the 1950 supply. It includes the cobalt content of ore, concentrates, oxide and other compounds, in addition to metal.

The Belgian Congo is the principal source of

(Continued)

cobalt. But more than half the planned increase will be from U.S. sources, through stepped-up cobalt recovery in refining nickel and copper, and by other methods.

Cobalt is needed in high-temperature alloys for jet engines. It's also needed for permanent magnets and cutting tools.

Meantime, the government has tightened controls on cobalt, already under complete allocation. Originally, allocations had been clamped on cobalt fines, cobalt oxide, cobalt powder and scrap containing more than 5 percent cobalt, used as sources of cobalt in commercial manufacture and processing. NPA has now extended controls to include compounds produced from ores, metal, concentrates and refinery residues.

#### Hooker borrows for big expansion

To finance expansion, Hooker Electrochemical, one of the largest producers of chlorine, caustic and chlorinated organics, has negotiated for a 25-year loan of $20 million. New York Life, John Hancock, New England Mutual, Provident Mutual and two others, through Smith, Barney & Co. and R. W. Pressprich & Co., are putting up the money.

The loan agreement calls for 3¾ percent notes, with no payments required on principal until May 1, 1957. Thereafter, the loan will be amortized at the rate of $800,000 a year up to and including May 1, 1977.

Hooker has received the first installment of $10 million, and has used $6 million of the new funds to retire its outstanding bank loans. It will borrow the balance of the loan on or before Nov. 28, 1952. The money will go into expansions at Niagara Falls and Tacoma, Wash., and for a new $10 million plant to be erected at Montague, Mich.

Present plans call for an outlay of $25 million by Hooker during 1952 and 1953. Added facilities and plant improvements will reduce costs, improve efficiency and quality of output. At Niagara Falls, capacity for diversified chemicals will be expanded.

Caustic and chlorine capacity will be increased substantially at the Tacoma, Wash., plant. Also at Tacoma, Hooker plans a 50 percent boost in ammonia capacity. The entire production of its $2 million anhydrous ammonia plant there has already been contracted for. The plant, designed by Chemical Construction Corp., has just gone into operation.

Hooker is likewise considering a $12 million plant in the Greater Vancouver area of British Columbia to produce chlorine and caustic for the pulp industry.

The new $10 million chlorine-caustic plant at Montague, Mich., will be built by H. K. Ferguson Co. When completed at the end of 1953, it will annually produce about 100,000 tons.

Electrolytic diaphragm cells of special Hooker design will convert salt brine into chlorine, caustic soda and hydrogen. Brine will be piped from the company's own wells near the plant.

Test drilling in the 200-acre brine field indicates high-purity salt at over a million tons per acre. One salt well is completed, others will be drilled this year.

Water will come from nearby White Lake, and electric power from the Muskegon, Mich., plant of Consumers' Power Co., about 14 mi. away. Deep water shipping may eventually be utilized from White Lake into Lake Michigan. Output of the new Montague plant, which will employ about 100, will go to Midwest industry.

By the end of 1953, Hooker's gross plant and equipment will be valued at about $58 million, or four times its $14.5 million value at the end of 1945.

#### New ammonia plant for Lion Oil

A new anhydrous ammonia plant, to produce 300 tons a day, will be built by Lion Oil Co. at Luling, La., about 14 mi. north of New Orleans on the Mississippi River. Most of the output will be converted into prilled ammonium nitrate. Texas Co. will supply natural gas.

The plant will cost an estimated $31 million. Lion will get the money from sale of 400,000 additional shares of common stock and from the sale to Equitable Life of $15 million of 3¾ percent 20-year sinking fund debentures. DPA has granted Lion a fast tax write-off on 50 percent of the plant's cost.

At its El Dorado, Ark., chemical plant, Lion Oil now produces about 10 percent of the nation's commercial output of synthetic nitrogen products. The new plant when completed will increase the nitrogen manufacturing capacity of Lion by about 53 percent.

#### Setback for Du Pont and ICI

Government trust-busters have won another round in their seven-year court battle against Du Pont and Imperial Chemical Industries. In New York, Federal Judge Sylvester Ryan says he will decree that Du Pont and ICI must divest themselves of three of their five jointly owned companies in Canada and South America, with total assets over $400 million.

Further, he finds that Du Pont will have to make its nylon patents available to all comers at reasonable royalty. Judge Ryan's reason: Du Pont didn't export nylon to the British market, thereby giving ICI's British licensee, Courtauld's, a monopoly; this damaged U.S. export trade.

Meantime, ICI has purchased Arnold Hoffman & Co., Inc., of Providence, R.I., and last year sold $8.2 million in the U.S., thus disproving that it offers Du Pont no competition in the U.S. And Du Pont has turned over its nylon process to Chemstrand, owned by two of its rivals, Monsanto and American Viscose.

(*Continued on page 110*)

NEW! NEW!

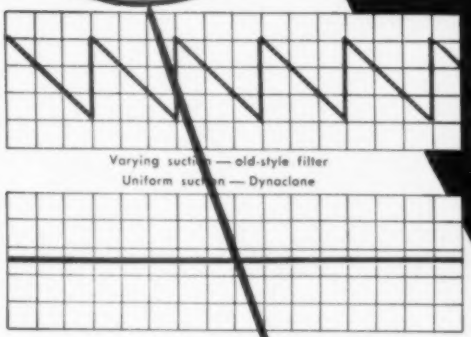
# NEW Cloth Screen Dust Filter

## SLY DYNACLONE*

You saw this ad 2 years ago

## offers 5 NEW ADVANTAGES!

1. Eliminates mechanical shaking.
2. Provides uniform suction at dust source.
3. Assures longer bag life . . . 4. minimum maintenance.
5. Keeps itself automatically and continuously clean without additional power or equipment.



Varying suction — old-style filter
Uniform suction — Dynaclone




*Send for descriptive bulletin just out on the new Sly Dynaclone — the ultimate in filter performance.*

This revolutionary new dust filter is another Sly first. Extremely simple and thoroughly dependable, it eliminates entirely the gremlin of mechanical shaking and provides uniform suction of air at dust source.

This uniform suction is achieved by a simple device which cleans the filter bags successively by a reverse flow of air—the same suction which draws the dust onto the filter cloth is reversed to blow it off.

Since this reverse air suction operates continually, the new Sly Filter requires no shutdowns for removing dust from the cloth.

No mechanical shaking or flexing device is needed, eliminating all strain and wear

The y equipment d a very minimu

**The Dynaclone isn't NEW any more!** It has been quietly at work in many industries with results beyond hopes and expectations.

The result of long experimentation and exhaustive tests, the Sly Dynaclone has thoroughly proved itself. It provides substantial savings over any other type of cloth screen dust collection. Write for complete information.

*PATENTED

**SLY** PIONEERS and LEADERS in INDUSTRIAL DUST CONTROL

**THE W. W. SLY MANUFACTURING CO.**
4771 Train Avenue • Cleveland 2, Ohio
NEW YORK • CHICAGO • PHILADELPHIA • SYRACUSE
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FISCHER & PORTER

# P-4

PNEUMATROL

*the 1st*

Flexible, die-cast building-block construction—six modes of control; right or left or dual case mounting, or point-of-measurement mounting.

High capacity (1.8 SCFM), non-bleed relay valve.

Double slack diaphragm design eliminates dead space and critical relay adjustment.

Large integral air passages permit maximum response, eliminate piping.

Accessible capillary restriction and integral filter.

Differential input assembly is an integral part of controller, assuring tracking.

Rugged, self-aligning "Barrel-Bearings"—eliminate friction.

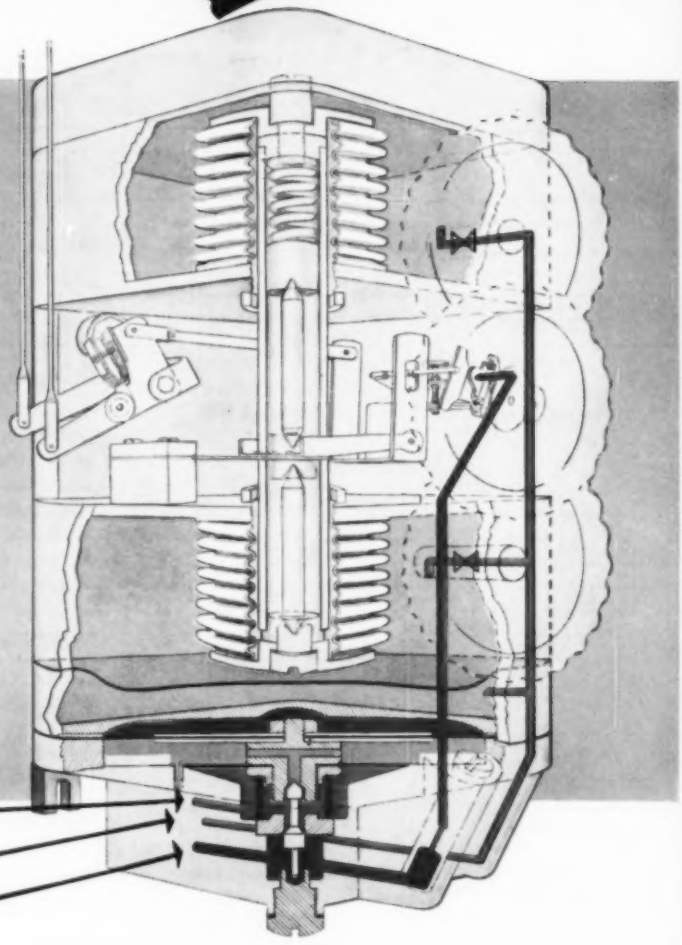
Jewel-mounted stainless steel flapper, rotatable around fixed stainless steel nozzle for proportional band adjustment and reversal of action.

Self-aligning, rigidly-coupled bellows assembly.

Beryllium-copper flexure spring, pivot-pin coupled to bellows without backlash or side thrust.

Long-path adjustable resistor valves for reset and derivative, O-ring sealed, non-jamming, calibrated 0.02—5 min. or 0.2—50 min.

Independent derivative vibration stabilizer; pneumatic balance action.



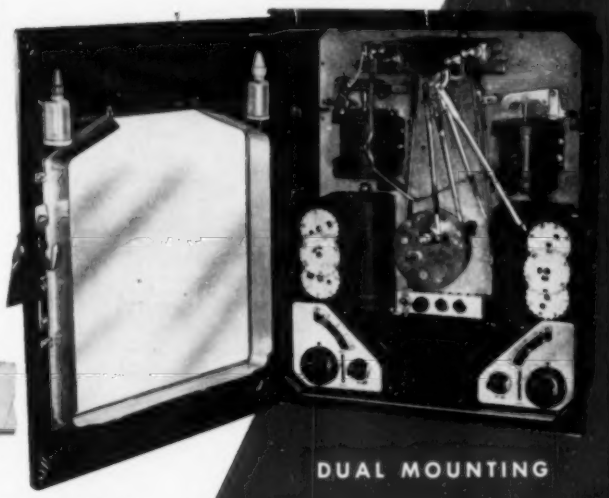

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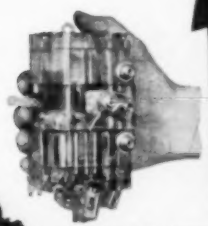
# ALL PURPOSE Pneumatic Controller

**for either instrument or point-of-measurement mounting**

**for**
- **rate of flow**
- **pressure**
- **differential pressure**
- **temperature**
- **liquid level**
- **viscosity**

The P-4 Pneumatrol is the *first* controller suitable for point-of-measurement installation as well as either single or dual case mounting. Knowing more about the many uses of the P-4 may lead to closer control of your processing operations. Get all the data NOW. The convenient coupon will bring you full information by return mail. Send for it while the subject is fresh in your mind.







The P-4 incorporates both proportional and derivative actions with automatic reset response for precise positioning... in stacked units, as shown in this transparent model.

## DUAL MOUNTING

- Complete mounting of transfer switch and regulator within the case.
- Greater panel space economy.
- New die-cast aluminum case and door.
- All accessories visible through door.
- External knobs for instant manual operation.
- *Everything* is inside the case, eliminates external manual panels.

For pneumatic-set, point-of-measurement control for use with graphic panels and miniature instruments, particularly where transmission lag must be eliminated for perfect control. Shown here mounted on the popular F & P 52 OK pneumatic transmitter.

FLOWRATOR

## FISCHER & PORTER COMPANY

**560 COUNTY LINE ROAD, HATBORO, PENNA.**

Please send me by return mail complete specifications on your new P-4 Pneumatrol.

NAME_____

POSITION_____

COMPANY_____

ADDRESS_____

CITY & STATE_____

Judge Ryan refused demands of Justice Department trust-busters that he punish Du Pont further by opening up all of its future patents. He called this demand unprecedented, punitive and destructive of that "driving incentive which has accounted for much of the remarkable development of the chemical industry."

To bring nylon to volume production, Ryan reminded the government lawyers, had cost Du Pont $196.8 million. And right now, he pointed out, Du Pont is spending $45 million a year on research. "Its past development of new products and processes," he declared, "has done much to promote our national economy and to meet the needs and requirements of national defense."

**Spencer will produce hexamine**

Hexamine will be added to Spencer Chemical's line of industrial chemicals. A unit for its production and also one for aqua ammonia will be constructed at Spencer's Chicago, Ill., plant. Made from ammonia and formaldehyde, both produced by Spencer, hexamine moves primarily into the plastics industry.

In other expansion moves, Spencer will put in two more nitric acid units at its Pittsburg, Kan., plant and two storage spheres at its Henderson, Ky., plant at a total cost of $1.85 million. These moves will increase Spencer's production of ammonium nitrate.

**New producer of zirconium and hafnium**

Zirconium and hafnium will be produced by the Carborundum Metals Co., Inc., new subsidiary of the Carborundum Co., for the Atomic Energy Commission.

Signing of the contract, according to A. Tammaro, manager of AEC's Chicago operations office, represents a significant step in AEC's program to encourage private enterprise, using private capital, to take on AEC jobs that can be handled in a conventional business fashion.

Zirconium is used in the construction of nuclear reactors because it absorbs neutrons at a low rate. Other advantages: corrosion resistance, ductility and strength.

Until the government began pilot-plant operation about two years ago zirconium had not been produced on a large scale. At present, AEC gets zirconium and hafnium from a government pilot plant at Albany, Ore., where purified zirconium oxide is converted into metal, and from Oak Ridge, Tenn., where the raw material is purified.

The present process for producing sponge zirconium was developed and put into pilot-plant production by the Bureau of Mines at its Northwest Electro-Developmental Laboratory at Albany, Ore. Cooperation of AEC and the Navy's Bureau of Ships helped to make the Bureau's work in Oregon a success. Both zirconium and hafnium are produced from zircon sand that comes from the beaches of Florida.

The contract with Carborundum Metals provides, according to AEC's Tammaro, for sale at a unit price of less than $15 per lb. of approximately 150,000 lb. of zirconium and hafnium sponge metal per year for five years. Carborundum Metals will design, build and operate its own production plant.

**Grace to make ammonia and urea**

At a cost of more than $20 million, W. R. Grace & Co. will erect a plant in the Midwest to produce ammonia and urea.

Each day the plant will synthesize 250 tons of ammonia from natural gas. Part of this ammonia will be converted into urea.

Grace has long experience in the chemical business in South America. Since its founding nearly 100 years ago the company has imported fertilizers into the U.S. —first guano from Peru and later nitrate from Chile.

Grace's wholly-owned subsidiary, Naco Fertilizer Co., with plants in the Carolinas, Florida, Ohio and California, is a big consumer of nitrogen. Plans are already under way for integrating the new ammonia-urea plant into Grace's other petrochemical manufacturing operations.

**Aftermath of the oil strike**

The oil strike is over. At its peak, 35 to 40 percent of the refining industry was shut down. The loss in gasoline production could have ranged from 15 million to 20 million barrels and distillate output as much as 10 million barrels.

Crude runs to stills, before the strike, were averaging about 6.5 million barrels daily. On May 17 the U.S. Bureau of Mines reported crude stocks for the industry at 281,781,000 bbl.

The oil strike quickly cut a swath through the chemical industry, especially petrochemical production on the Gulf Coast. When the refineries shut down, makers of petrochemicals were deprived of raw materials. And the closed refineries could no longer take sulphuric acid, caustic soda, chlorine and other products of the chemical industry.

When the Port Arthur, Tex., refinery of the Texas Co. shut down, the plant of Jefferson Chemical at Port Neches had its feedstocks cut off. Jefferson, in turn, could no longer take chlorine from the Lake Charles, La., plant of Columbia-Southern Chemical Corp.

Adding to the plight of the chemical industry, many of its plants were closed by its own locals of the CIO Oil Workers. Thus, while Lion Oil's El Dorado, Ark., refinery, which is AFL, did not close down, its chemical plant, with a union of the CIO Oil Workers, was picketed. And at Cactus, Tex., the CIO Oil Workers likewise picketed the Phillips Chemical.

In its handling of the disputes in the oil strike, the Wage Stabilization Board regained some, but not much, of its lost prestige. By approving only 15c. of an 18-c. settlement, it established a ceiling at the

(*Continued on page 112*)






Every small worm gear unit is built to precision standards—as outstanding in quality and performance as larger size Clevelands.
Illustrated above are the 10 AT (left) and 00 D (right) speed reducers.

# Enjoy the benefits of worm gear drives in smaller CLEVELAND speed reducers

WHEN you want a quiet, powerful, dependable drive for a small machine, choose a Cleveland Worm Gear Speed Reducer.

As built by Cleveland, the worm gear reducer is a drive of many advantages:

1. It is compact and inherently quiet, transmitting power with smooth, uninterrupted torque flow.
2. Its right-angled design saves valuable space.
3. It has a minimum of moving parts.
4. Shock load resistance and other factors of safety are high.
5. Rate of wear of case hardened steel worm on nickel-bronze gear is very low, insuring long life.

Write for Bulletin 114F which illustrates and gives engineering data on smaller size Clevelands—many now available for immediate delivery. The Cleveland Worm and Gear Company, 3273 E. 80th St., Cleveland 4, O.

*Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.*



CLEVELAND
Worm Gear
*Speed Reducers*

15 c. figure for other oil companies and unions unless they can show unusual circumstances. This action helped to settle strikes involving about 80 companies.

Even so, Congress still seems intent on reorganizing WSB to give public members control, if not all the membership, and to deny WSB any authority to handle labor disputes. Here are some of the reasons:

WSB showed again that it is willing to approve increases beyond its regulations if they are proposed by big employers and unions, although it made sure this time that it had Stabilizer Putnam's approval. Failure to clear with Putnam and former Defense Mobilizer Wilson is considered one of the mistakes in handling the steel crisis.

WSB showed, too, that it is willing to go about 5 c. above the cost-of-living allowance in a voluntary case or a dispute. This, roughly, is the amount by which the oil approval and steel recommendation exceeded the rise in living costs. It approximates the 4-c. productivity increase that the auto workers got in addition to a cost-of-living bonus.

When it cut the ceiling from 18 c. to 15 c. in the agreement between Farmers Union Central Exchange at Billings, Mont., and Local 443 of the CIO Oil Workers, thus setting the pattern for other settlements, the WSB wasn't quite the public hero it appeared to be. For this agreement and another by Local 535 of the same CIO union with Rock Island Refining Corp. at its Zionsville, Ill., plant were the only ones with increases originally higher than 15 c. More important, they covered a total of only 286 employees (137 at Farmers Union Central Exchange and 149 at Zionsville).

What WSB had its eyes on were the really big, and more important, settlements already made at the 15-c. level and awaiting board approval. They were: Standard Oil of California and the Independent Union of Petroleum Workers, covering 5,000 workers in California; Standard Oil of California in seven western states, Alaska and Hawaii with the Independent Petroleum Workers, covering 3,550; Cities Service Refining, Lake Charles, La., and Lake Charles Metal Trades Council, AFL, taking in 1,500; Phillips Petroleum, Phillips, Tex., and the AFL Operating Engineers, covering 2,900.

These agreements were at 15 c. In addition, there was another at 13-c. involving Pure Oil Co., Newark, Ohio, and Oil Refineries Independent Association. WSB will approve 2 c. more here if called to do so.

So what WSB really did was to approve agreements already reached between the oil companies and the AFL and independent unions, forcing the CIO to back down. To have gone higher than 15 c. would have upset these larger agreements—with union demands to match the higher figures—and this would indeed have been unstabilizing, something WSB is supposed to avoid.

About 10 c. could have been approved because of the rise in the BLS cost-of-living index. WSB approved 15 c., with Putnam's consent, as "fair and equitable and not unstabilizing." Public members voted with labor on the 15 c. (rejecting 18 c., 16½ c. and industry's proposed 10-c.) but made their approval hinge on Putnam's acceptance.

Most oil settlements also provide for increase in second and third shift differentials from 4 and 6 c. to 6 and 12 c. There was no industry or area practice upon which to base this increase, although WSB had months ago approved such shift differentials—on a "non-precedent" basis—for certain Standard Oil refineries. The third shift differential is 3 c. higher than WSB recommended in steel. The 6 and 12 c. are less than the 5 and 7½ percent, or about 10 and 15 c., which the auto workers get.

In both of the Standard of California pacts, the company asked, and WSB approved, a 7½ percent differential for day workers when working night shifts.

In the Cities Service and Phillips Petroleum cases, there had been no strikes.

Finally, the AFL says it was not part of the coalition of CIO and 21 other unions that banded together to bargain with the oil companies. Only one AFL local bolted to join the coalition, and its leader was fired AFL says.

**General Tire's new Ohio chemical plant**

Resins for the plastics industry, new types of rubber, rubber processing chemicals and synthetic latices are now being produced in the new chemical plant of General Tire & Rubber Co. at Mogadore, Ohio. The plant is just reaching its full production stride.

**Allied takes to the tall corn**

Allied Chemical & Dye Corp. plans to build a $25 million plant near La Platte, Neb., to produce ammonia and urea. Northern Natural Gas Co. has asked the Federal Power Commission for authority to install facilities to supply natural gas to the proposed plant. If FPC approves, construction of Allied's new urea plant will get under way. It will be Allied's first Nebraska plant and first of its kind in the Nebraska-Iowa area.

Allied has picked up options on plant sites about 15 miles south of Omaha, near the junction of the Missouri and Platte Rivers.

If FPC gives the nod, work will start this summer and will be completed within 18 months to two years. The plant will employ about 450.

Allied will get ammonia and carbon dioxide for urea production from natural gas. Because of its high nitrogen content (46.6 percent compared with 32.5 percent or less for other solid nitrogen fertilizers) urea means low transportation and handling costs for farmers. Urea is also used increasingly as a cattle feed, providing up to 30 percent of the total protein fed. Other uses for urea are in adhesives and plastics. Ammonia will likewise be marketed. —*End*

# If Your Research and Development Program Involves Sulfonations... get these

## 4 TIMELY AIDS ON

# Sulfan*

**STABILIZED SULFURIC ANHYDRIDE**




**WHAT IT IS**

**HOW IT CAN MEET YOUR NEEDS**

**HOW TO USE IT**

**HOW TO HANDLE AND STORE IT**

**GENERAL CHEMICAL SULFAN** is stabilized liquid sulfur trioxide. It provides Industry with sulfuric anhydride in a convenient "workable" form, ideally suited to many processes involving sulfonations and sulfations.

**WITH THE DEVELOPMENT OF SULFAN,** many long-recognized, but hitherto impractical uses of sulfuric anhydride have been made possible. In production of detergents, dyestuffs, pharmaceuticals, textile wetting agents, organics, plastics, and other products, SULFAN has given evidence of offering important economies and advantages. Possibly it can do the same for you.

**FOR RESEARCH AND DEVELOPMENT GROUPS** interested in studying this important new chemical tool, experimental quantities of SULFAN are available. In addition, General Chemical has prepared four technical bulletins on SULFAN. Each one is packed with useful information. You will find them extremely helpful if your work involves sulfonations, or indicates their use. When writing for your copies, please fill in coupon completely, or make inquiry on your business letterhead.

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**Bulletin SF-1—SULFAN**
Gives potential uses, physical properties.

**Bulletin SF-2—"Reactions of $SO_3$"**
Lists reactions with aliphatic organic compounds, reactions with aromatic organic compounds, reactions with inorganic materials.

**Bulletin SF-3—"Storage, Handling and Use of SULFAN"**
Safety and precautions, laboratory evaluations, sulfonation techniques, bulk handling, vaporization of SULFAN.

**Bulletin SF-4R—"Use of SULFAN in manufacture of Alkaryl Sulfonate Detergents".**
Contains latest information on the SULFAN method.

BASIC CHEMICALS
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FOR AMERICAN INDUSTRY

*SULFAN is General Chemical's registered trade-mark for liquid sulfur trioxide.

**GENERAL CHEMICAL DIVISION,** Allied Chemical & Dye Corporation
40 Rector Street, New York 6, N. Y.

Please send me the following Technical Bulletins on SULFAN. (Check those that interest you).

☐ Bulletin SF-1 "Sulfan" ☐ Bulletin SF-2 Reactions of $SO_3$ ☐ Bulletin SF-3 Uses & Handling ☐ Bulletin SF-4R Use in Detergent Mfg.

Name_____
Organization_____
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Address_____
City_____ Zone_____ State_____

CE-5




**Picture shows** how special construction of Benson aluminum drums facilitates handling with fork lift trucks. Rough treatment is no problem because Benson aluminum drums are well designed and sturdily constructed from strong aluminum alloys.

# "Aluminum drums are best for acetic acid"

**says Paul C. Thomas, President, Moreland Chemical Company, Inc., Spartanburg, S. C.**

"We have been using Benson aluminum drums, fabricated with Kaiser Aluminum, for about a year for packaging and shipping Acetic Acid . . ." writes Mr. Thomas.

"These drums are easily filled and, due to their special type construction, withstand bumping and rough handling better than other style containers. This construction also aids in the ease of handling with fork lift trucks.

"Since aluminum drums are resistant to corrosion, they are easily cleaned for refilling.

"The light weight of aluminum drums has proved very economical, and as transportation costs increase this becomes more important.

"We are thoroughly convinced that aluminum drums are best suited for our use in packaging of Acetic Acid," Mr. Thomas concludes.

Although most Kaiser Aluminum today goes to meet the needs of the national security program, you can *plan now* to take advantage of aluminum in your operations. For Kaiser Aluminum is expanding facilities to increase its production of primary aluminum 137 per cent!

Call any Kaiser Aluminum office for complete information and for current availability. Kaiser Aluminum is also sales agent for aluminum drums made by Benson Manufacturing Company, Inc. 65 offices and warehouse distributors in principal cities. Kaiser Aluminum & Chemical Sales, Inc., Oakland 12, California.

**Glacial Acetic Acid** is only one of many chemicals that can best be shipped or packaged in aluminum drums. Among these are: Methul Salicylate, Hydrogen Peroxide above 30%, Glycerine, Fatty Acids, Nitric Acid above 95%, Essential Oils, Formaldehyde, Ammonium Thioglycolate, Acetic Anhydride, Edible Oils, Acetaldehyde, Benzaldehyde, Ammonium Nitrate, Special Petroleum Products.

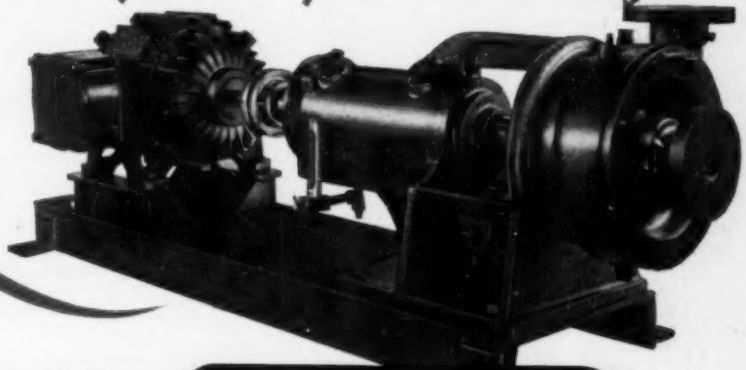
# Kaiser Aluminum

***Setting the pace—through quality and service***

# WHY BUY MORE PUMP THAN YOU NEED?

## this standard pump can be used on many special jobs—

*may save you hundreds of dollars*



**ALLIS-CHALMERS**
*General Purpose*
**Chemical Pumps**

HERE'S A TYPICAL CASE! An Eastern chemical company has standardized on Allis-Chalmers general purpose chemical pumps. They now handle chemicals up to 500 F with pumps costing hundreds of dollars less than the pumps they used formerly.

Allis-Chalmers general purpose pump isn't meant to do *every* job in the chemical industry. On the other hand, it can't be beat on many applications and costs much less than refinery type pumps widely used in the industry. It will handle a big percentage of chemical industry jobs, for several reasons:

- It's built in most used size range . . . to 1200 gpm, 250 ft head.
- Handles liquids in most common temperature range . . . up to 500 F.
- Built in wide choice of materials. Can be provided with six different sealing arrangements, including a water cooled stuffing box . . . somewhat unusual in a pump of this type.

Another feature is the large, easily changed reservoir of oil for lubricating the bearings. Pedestal is of rigid, corrosion resistant cast iron. As you can see from the picture, there is plenty of room between pump and pedestal for easy maintenance.

Allis-Chalmers can supply you with a complete pumping unit — pump, motor, drive, and control — all of coordinated design and manufacture and all mounted on a rigid base ready to install.

*To get more information on Allis-Chalmers General Purpose Chemical Pumps, call your Allis-Chalmers Authorized Distributor or District Office. Or write Allis-Chalmers, Milwaukee 1, Wis., for Bulletin 52B7638.*

A-3666

***Sold . . .***
***Applied . . .***
***Serviced . . .***

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.



**MOTORS** — ½ to 25,000 hp and up. All types.

**CONTROL** — Manual, magnetic and combination starters; push button stations and components for complete control systems.





**TEXROPE** — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

*Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks.

# ALLIS-CHALMERS

A-C ALLIS-CHALMERS

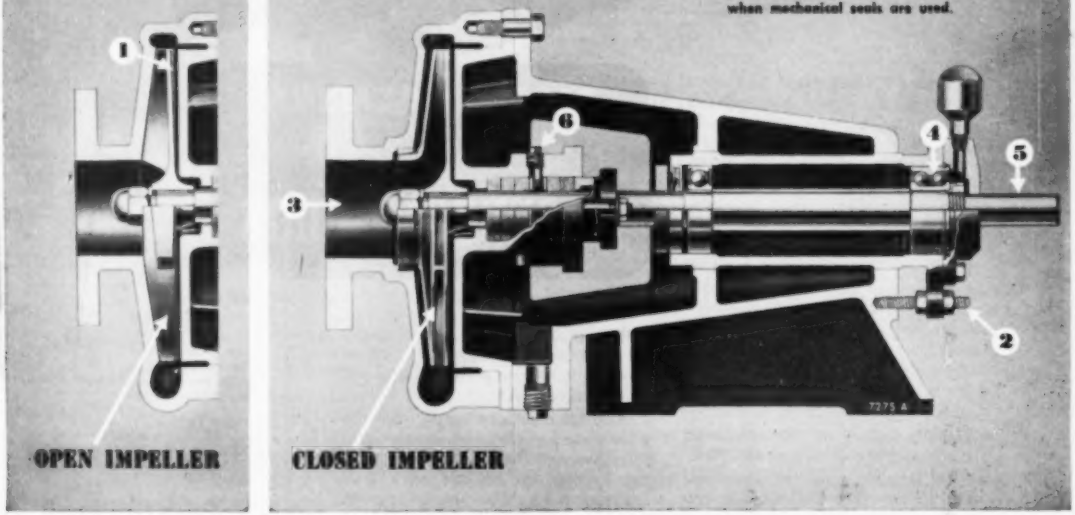
# DE LAVAL *designed*

## CP PROCESS PUMPS

*Look at these design extras*

**SIZES TO 6" CAPACITIES TO 1800 GPM HEADS TO 200'**

1. *Eductor vanes* on the back of open impellers develop higher pressures than pumping vanes. This reduces end thrust, relieves stuffing box pressure, keeps back of impeller clean and prevents binding.
2. *Rotor adjusting screw* makes it simple to pull the impeller off the shaft. No special tools are needed.
3. *Large throat diameter* keeps entrance velocities low . . . lessens the danger of cavitation.
4. *Husky double row ball thrust bearings* insure long uninterrupted service.
5. *Heavy stainless steel shaft* is designed for severe operating conditions.
6. *Inlet-outlet water seal connections* provide sealing liquid and cooling when mechanical seals are used.

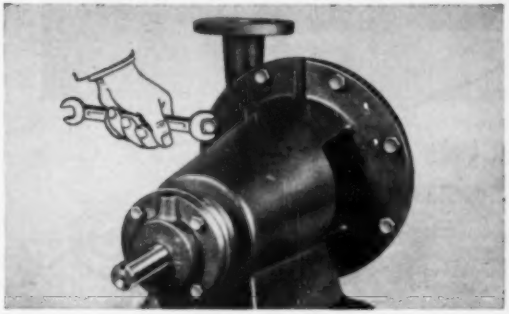



De Laval CP Process Pumps are *versatile* on many counts. Impellers and seals can be quickly switched to meet changing service requirements. Adjustments for wear are simple to make. Repair parts are standardized. And, in addition, these pumps are specially designed for hundreds of general service process applications.

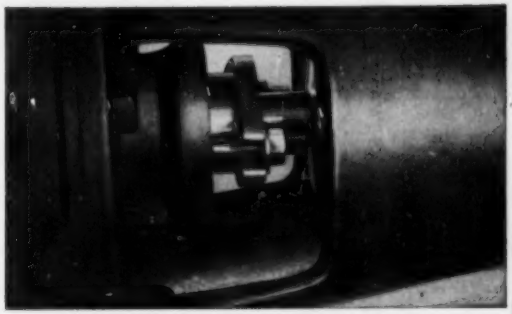
Careful selection of proven corrosion resistant materials permit CP pumps to handle practically all types of acids and alkalies. Whether liquids are hot or cold, viscous or corrosive, clear or filled with suspended solids, these pumps will keep giving efficient service for years.

Whatever your processing application, it pays to investigate the De Laval line of double-duty CP pumps. Bulletin 1125 gives complete data on these pumps, tells why they are . . . **DESIGNED TO STAY ON THE LINE.**

# *for double-duty performance*



TWO PUMPS IN ONE! When service requirements change, you can *quickly* convert these pumps from closed to open impeller—and back again! As the cutaway drawing shows, all you need do is switch the pump volute and impeller. *There's no need to buy a whole new pump!*



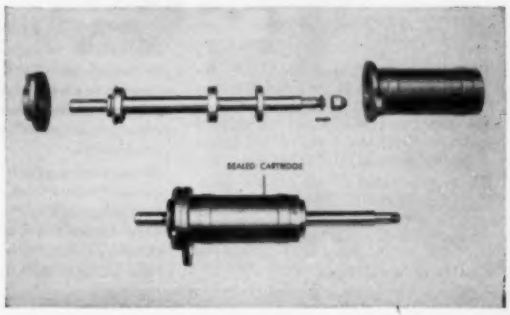
YOU CHOOSE THE SEAL! You can specify either mechanical seals or flexible packing . . . and change from one type to another *in your plant.* Gland faces are pre-machined and drilled for easy conversion to mechanical seals. Area around gland is large, easy to work in.

# *...and for time-saving maintenance*

HERE'S EXTRA PUMP LIFE! On *closed-type,* turning the external adjusting screw moves entire rotor and impeller forward, permits you to adjust for proper clearance between case and *tapered* wearing ring. On *open-type,* simply face off worn parts of impeller and case, re-assemble pump and reposition impeller with adjusting screw.

DOUBLE-DUTY REPAIR PARTS! Two sizes of shafts, shaft lock-nuts, bearings, bearing cartridges and pedestals fit *all nine sizes* of De Laval CP Process Pumps. This versatile feature is another of the many De Laval design advantages that help trim costs by keeping your stock of repair parts at a minimum.








**DE LAVAL** *Process Pumps*



DE LAVAL STEAM TURBINE COMPANY
TRENTON 2, NEW JERSEY

MONSANTO
CHEMICALS — PLASTICS

FOR YOUR INFORMATION

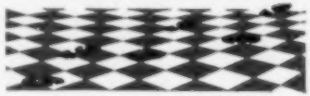
Intermediates
Emulsifier
Plasticizers
Alkyd Ingredient
Silica Aerogel
Coplasticizer
Sodium Tripoly Phosphate
Sodium Pyrophosphate
Synergistic Action
Defoaming Agent
Rust Control



## Emulsifier L puts more "kill" in pesticides

Monsanto Emulsifier L, developed especially for use with insecticides and herbicides, is a well-balanced liquid blend of surface-active agents. Because of its versatility, it is highly efficient with such insecticidal and herbicidal chemicals as Chlordan, DDT, 2,4-D Esters, 2,4,5-T Esters, Aldrin, Dieldrin, Lindane, Parathion and Tetraethyl Pyrophosphate. For information on Emulsifier L and its many applications, contact the nearest Monsanto Sales Office or mail the coupon.

## Plasticizers that make floor tile grease resistant



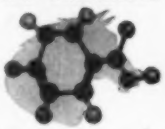
Monsanto Santicizers* 8, 140 and 160 and tricresyl phosphate are efficient, economical, available plasticizers to put sales-making qualities into your floor tile.

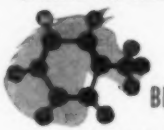
These plasticizers are compatible with resins used in the floor tile industry such as asphalt-coumarone-indene and vinyl types. They impart grease resistance and improved processing characteristics.

For information on the use of Monsanto Santicizers 8, 140 and 160 and tricresyl phosphate in the manufacture of floor tile, mail the coupon or contact the nearest Monsanto Sales Office.

## TWO CHEMICAL "WORK HORSES"

BENZOIC ACID





BENZYL CHLORIDE

These Monsanto Intermediates serve industry in such varied ways that they can be called chemical "work horses." Both are made to Monsanto's high quality standards. Both are available for immediate delivery.

*Benzoic Acid, Technical*—Used in the manufacture of dyestuffs and aromatic and medicinal esters. It is a dispersant in pigment-vehicle grinds. It controls viscosity, permitting reduced acid number, in alkyd resin manufacture.

*Benzyl Chloride*—Employed in synthesis of pharmaceuticals, dyestuffs, flavor and perfume bases, plasticizers, quaternary ammonium compounds and rubber accelerators.

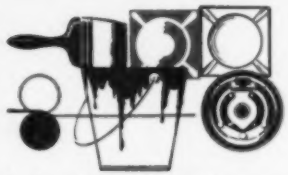
Samples are available to qualified chemists who wish to test or experiment with these chemicals. For information and a copy of a new technical bulletin on benzyl chloride, contact the nearest Monsanto Sales Office or mail the coupon.

## Maleic anhydride speeds alkyd processing

The addition of from ½% to 2% of Monsanto Maleic Anhydride to phthalic-type alkyds reduces processing time as much as one third. In addition, it improves color, hardness and gloss.

The following table gives you important data concerning the use of maleic anhydride in alkyds. For further information, mail the coupon or contact the nearest Monsanto Sales Office.

| Phthalic Anhydride | Maleic Anhydride | Alkyd Processing Time at 500° F. Minutes | Acid Value | Color | Air Dry to Touch Minutes 0.02% Cobalt |
|---|---|---|---|---|---|
| 100% | None | 54 | 9.0 | 8.0 | 60 |
| 99½% | ½% | 46 | 10.0 | 7-8 | 60 |
| 99% | 1% | 42 | 11.0 | 7-8 | 60 |
| 98% | 2% | 35 | 12.0 | 6-7 | 60 |



## Santocel used in wide range of applications

Whatever your problems—whether of processing, finishing or some characteristics of your final product—it will pay you to get well acquainted with Santocel,* Monsanto's silica aerogel.

This phenomenal material is extremely porous, incredibly light, chemically inert. Its versatility is almost unbelievable. Already it has found applications ranging from a flatting agent for lacquers through a thickening agent for lubricants to a mold lubricant for rubber. For further information on Santocel, mail the coupon or contact the nearest Monsanto Sales Office.

## Monsanto reports on corrosion-control test in tankers

Several months ago a test was initiated to determine the effectiveness of Monsanto Santolene* C in controlling corrosion in tankers. This is a report of the results.

*How test was made:* Strips in two cargo compartments in a tanker were sandblasted clean. Petroleum products carried in these compartments were treated with Santolene C at the rate of 12#/1000 bbls. Two other compartments were cleaned for comparisons. Untreated petroleum products were carried in them. One treated and one untreated test compartment always made the return trip containing salt water ballast.

*Here are results:* After 8 months, the compartments were inspected. Sandblasted strips in tanks carrying Santolene C had slight, soft scale that could be removed by wiping. Areas not sandblasted had a dull, oily appearance. There was apparently no new scale on these areas and the scale

present was clinging tightly to the sides. (This was scale that had been left on the metal when the test started.)

A hard rust-red scale had formed on the sandblasted areas of the compartments without Santolene C. Large sheets of old scale were falling from the sides.

During the period of the test, 153,000 pounds of scale was removed from all compartments of the ship. Scale removed from the two tanks in which Santolene C treated products were carried was 50% to 60% less than that removed from the untreated compartments of the ship.

If you have a corrosion problem in carriers or in static storage of light petroleum products, consider Santolene C. For literature and technical information, mail the coupon or get in touch with the nearest Monsanto Sales Office.

• • • • • • • • •

## Fast delivery on low-cost extender-type PLASTICIZER

Now available in unlimited quantities, Monsanto HB-40 is a low-cost extender-type plasticizer that's finding wide use in producing vinyl extrusions, vinyl pastes, vinyl slush moldings, vinyl calendering . . . It is also of special interest as a low-cost plasticizer in polystyrene casting resins, polystyrene adhesives, molding polyvinyl carbazole, strip coatings for metals, floor-tile compositions, asphalt-base paints.

LCL price is 17¢ a pound—less in carloads . . . Samples furnished if desired.

## Two important PHOSPHATES

Monsanto Sodium Tripoly Phosphate (STP) and Monsanto Tetra Sodium Pyrophosphate (TSPP) are two prominent members of the polyphosphate family that have wide cleaning applications across the front of American industry. They find uses as detergent aids for synthetic detergents, in dishwashing compounds, in bottle-washing operations, in dairy and metal cleaning, de-inking of paper, soap builder.

## STP sodium tripoly phosphate

Monsanto STP is one of the newest of the sodium phosphates. It combines outstanding calcium sequestering power with excellent detergency, physical and chemical stability and high water solubility.

The sequestering action and water softening power of STP (as well as of TSPP) is of particular significance because of its value in the control of hard water. In cleaning operations where soap is used, sequestration eliminates the formation of insoluble scum and curds usually formed when soap is used in hard water.

Monsanto STP has a relatively high solubility in water—in this respect it has an advantage over TSPP, since at room temperature it is about 4 times as soluble. For instance, STP is soluble to the extent of 15 parts of water at 15° C., and 29 parts per 100 of water at 90° C.



High detergency is another outstanding property of Monsanto STP—when combined with other alkalies, synthetic detergents or soap, it makes an outstanding contribution to the detergency of the mixture. This characteristic is particularly valuable in industrial detergent compositions for dairy equipment and metal cleaning, dishwashing.



## TSPP tetra sodium pyrophosphate

Monsanto TSPP is important to industrial cleaning because it combines unique properties as a water softener, emulsifier, dispersing and deflocculating agent, detergent and a builder for soaps and synthetic detergents. Additionally, it is characterized by unexcelled purity, chemical and physical stability.



The synergistic action of TSPP (as well as STP) is one of the most valuable properties of these two Monsanto polyphosphates when either is used in combination with synthetic detergents. Synergism is defined as a "cooperative action of two or more separate agencies (TSPP and Santomerse* No. 1, for instance) which results in a combined effect that exceeds the average of the two effects taken independently." Example:

If Santomerse No. 1, with a detergency of 100%, is combined with TSPP with a detergency of 75%, the resultant detergency of the mixture would supposedly be the average of the two, or 87½%. Actually it is much more—NEARLY 110%.



## Looking for a defoaming agent?

There's a new Monsanto high-molecular-weight alcohol ester having excellent action as a defoaming agent. It is called Sterox* 110 (formerly AE-1).

Among present applications of Sterox 110 (formerly AE-1) are—Defoamer in producing alcohol from molasses . . . defoamer in producing glycerol from fats . . . foam control in the manufacture of yeast and other fermentations . . . elimination of foam in certain bottle-washing operations . . . meeting foam problem in polystyrene latex water dispersions . . . lubricant for vinyls that are extruded or calendered . . . coplasticizer for rubber hydrochloride and chlorinated rubber.

These uses may suggest others to you that may have value in your own processing. If you'd like samples for experimentation, write Monsanto. Also ask for Technical Bulletin No. P-140. Use the convenient coupon.

• • • • • • • • •

MONSANTO CHEMICAL COMPANY, 1700 South Second Street, St. Louis 4, Missouri. District Sales Offices: Birmingham, Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Portland, Ore., San Francisco, Seattle, Twin Cities. In Canada, Monsanto Canada Limited, Montreal.

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CHEMICALS — PLASTICS

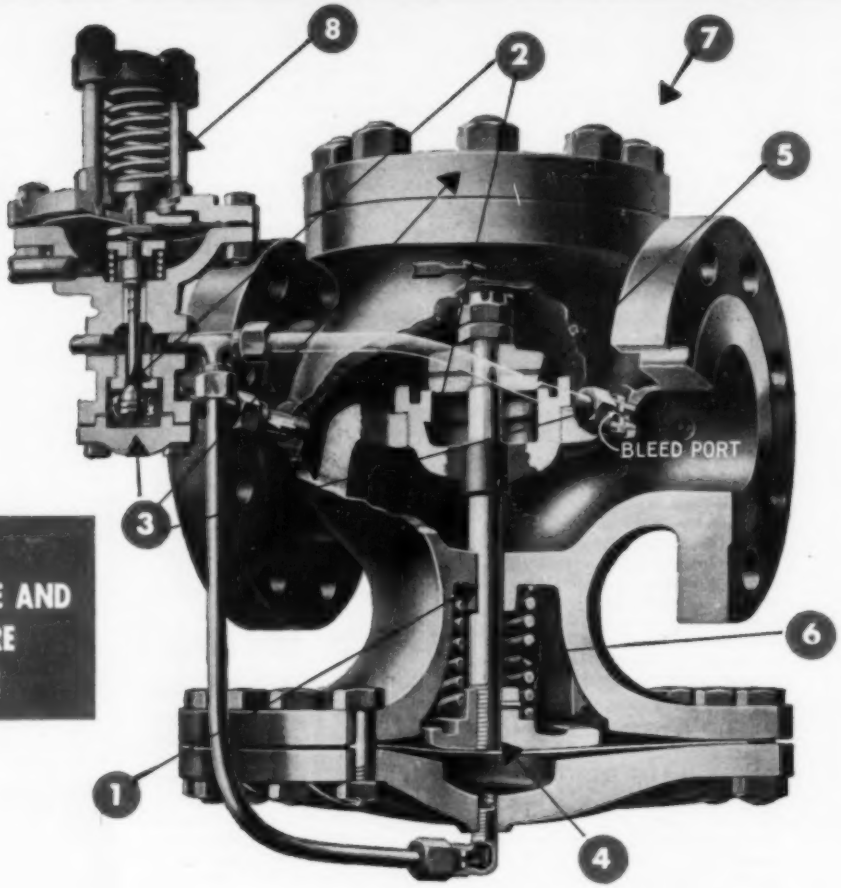
SERVING INDUSTRY . . . WHICH SERVES MANKIND

SEND INFORMATION:
☐ Emulsifier L. ☐ Santicizers.
☐ Maleic Anhydride. ☐ Santocel.
SEND LITERATURE:
☐ Benzyl Chloride Bulletin. ☐ HB-40 Coplasticizer. ☐ Sodium Tripoly Phosphate. ☐ Tetra Sodium Pyrophosphate. ☐ Sterox 110 Defoaming Agent. ☐ Santolene C.
SEND SAMPLE:
☐ Benzyl Chloride. ☐ Benzoic Acid. ☐ Sterox 110 Defoaming Agent. ☐ HB-40.

MONSANTO CHEMICAL COMPANY
1700 South Second Street, St. Louis 4, Missouri
Please send, without cost or obligation, information, sample or literature as indicated at the left.

Name.....Title.....
Company.....
Street.....
City.....Zone.....State.....

# THESE SPENCE FEATURES *Reduce*




**A TYPICAL SPENCE PRESSURE AND TEMPERATURE REGULATOR**

**LESS DOWN-TIME** of the system! Less time and money wasted on replacement of parts! Thousands of installations throughout the country have proved that Spence Self-Operated Regulators stay "on the line" . . . provide *dependable, trouble-free* pressure and temperature control. Users know these precision-engineered Spence units rarely need extensive repairs or special attention. Here are a few of the Spence design features that help keep *maintenance at a minimum:*

**1 PACKLESS CONSTRUCTION**—All Spence main valves and most pilots are built without stuffing boxes. This packless construction saves many maintenance man-hours because it eliminates the need for closely fitted parts which may stick or bind due to uneven expansion or foreign matter.

**2 EASY TO CLEAN**—The seat and disc of the main valve and pilot can be cleaned and any working part removed *without taking the main valve out of the line.*

**3 NO DISMANTLING FOR INSPECTION**—Special openings are provided to inspect the main valve disc, the pilot valve member and the SECO Metal bleedport. Inspection is easier, too, because the pilot is not an integral part of the main valve. The pilot is protected by an accessible built-in strainer.

**4 LONG-LIFE METAL DIAPHRAGMS**—Spence metal diaphragms, under usual conditions, never require replacement. Spence Regulators have few moving parts and those few are ruggedly constructed and seldom require attention.

## SPENCE PRESSURE *and* TEMPERATURE

# Maintenance...Cut Costs

## BUILT TO LAST FOR YEARS!

**That's the reason Spence Self-Operated Regulators lower over-all costs. Dollar for dollar, you can count on quality performance for a longer period of time. Look at three of many Spence features that assure long regulator life:**

**5 DURABLE SECO METAL SEATS AND DISCS**—Spence seats and discs are made of durable SECO Metal which resists wiredrawing. *More than twenty years of experience* with SECO Metal in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

**6 SPRING OUT OF PATH OF STEAM**—The spring in the Spence Regulator is out of the path of high-pressure steam or other fluids flowing through the valve. Since the spring operates at low unit stress, it has exceptionally long life.

**7 LESS FRICTION**—All Spence Regulators are built with *packless* main valves which are actuated by large, balanced diaphragms. This design minimizes friction. Valves remain unaffected by changes in service conditions or length of service.

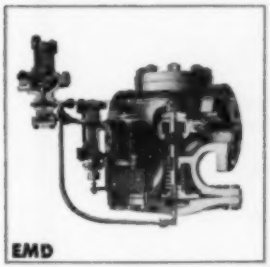
### WHY SPENCE UNITS REGULATE ACCURATELY

**8 YOU CAN BE SURE** of accurate regulation because *sensitive* pressure or temperature pilots control the main valve of every Spence unit. This unique design enables the Spence Regulator to serve many functions and handle all the various types of fluids under a wide range of conditions.

One of the great advantages of this Spence design is the interchangeability of all pilots on all sizes of main valves. Any main valve can be changed from a pressure to a temperature regulator or vice versa *simply by substituting one type of pilot for another.*

### WIDE RANGE OF SIZES

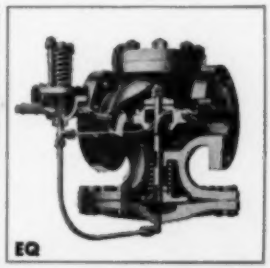
Spence Regulators are built in sizes from *¼" to 12"* for service with *air, steam, water, oil or gas.* With minor adjustments, any Spence Regulator can be easily switched from one service to another.



EMD



E2T100



EQ

The Type EMD Pressure Regulator includes a SPENCE Solenoid Pilot to cut it on and off electrically • The Type E2T100 Temperature Regulator in effect is a pressure regulator which is constantly reset by small variations in temperature at the sensitive thermostat. • The Type EQ Back Pressure Regulator is a self-operated, packless unit which controls its own initial pressure. The general construction is the same as the Type ED Pressure Regulator.

### FREE BULLETIN GIVES ALL THE FACTS

YOU WILL FIND complete engineering details and selection data on Spence Regulators in free bulletin No. 5000. It features a *full color, fully illustrated description of the operating cycle* of a Spence Regulator. Send for your copy of this valuable bulletin today.



**SPENCE ENGINEERING COMPANY, INC.**
**WALDEN, NEW YORK**

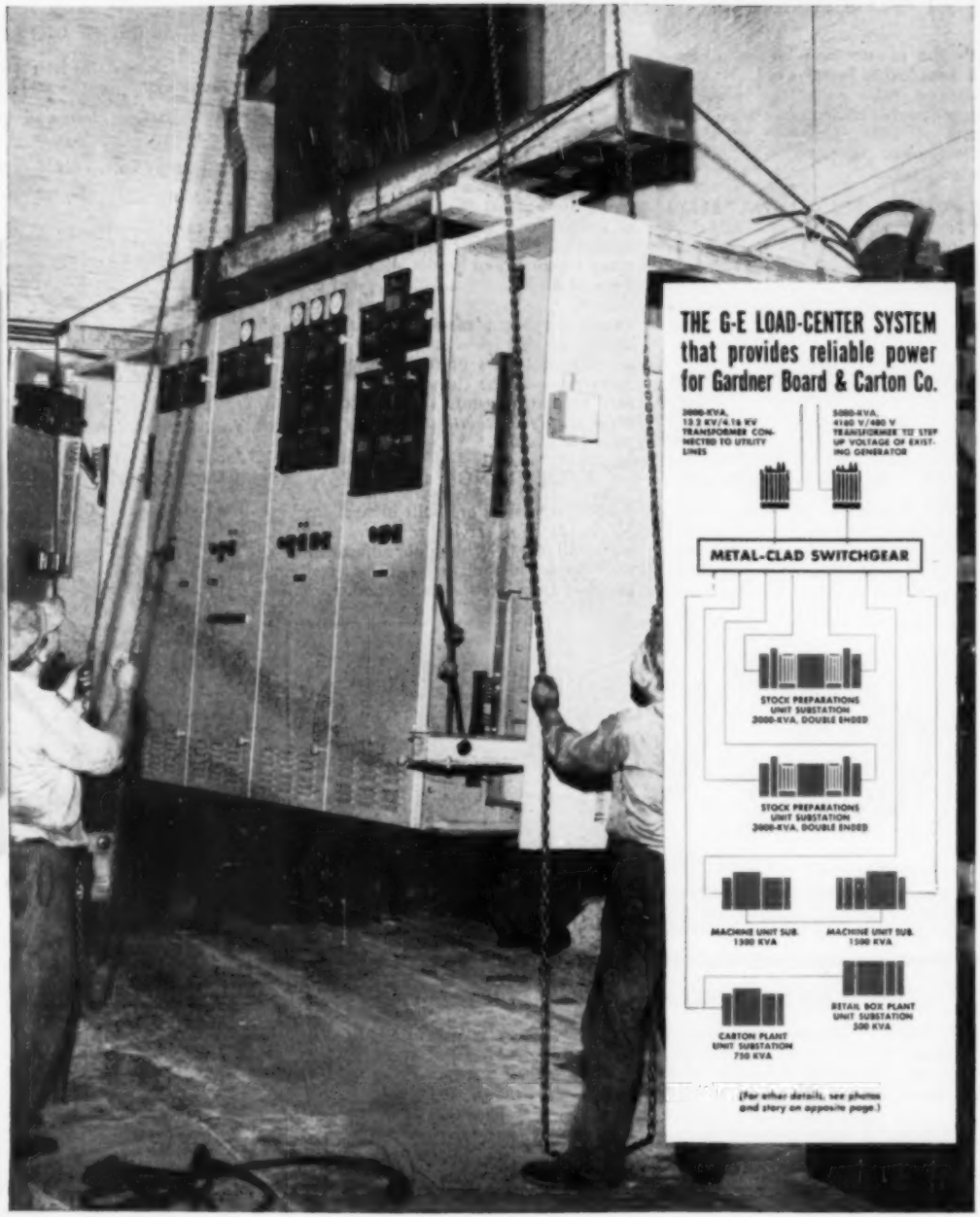
### PARTIAL LIST OF USERS

The Cleveland-Cliffs Iron Company
Tennessee Coal, Iron and Railroad Company
The Springs Cotton Mills
Ford Motor Company
Cochrane Corporation
Philadelphia Electric Company
Pennsylvania Power & Light Company
L. H. Gilmer Company Div. of United States Rubber Co.
York Corporation
Jones & Laughlin Steel Corporation
The Duluth Steam Corporation
Rochester Gas and Electric Corporation
Consolidated Gas Electric Light and Power Company of Baltimore
Phenix Natural Gas Company
Cutter Laboratories
National Tube Company
The Atlantic Refining Company
Great Lakes Steel Corporation
Union Electric Company of Missouri
Todd Shipyards Corporation
Oxford Miami Paper Company
Land O'Lakes Creameries, Inc.
Ohio Edison Company
General Electric Company
R. J. Reynolds Tobacco Company

Spence

# REGULATORS

# Ohio plant avoids shutdowns with




**G-E FACTORY-ASSEMBLED POWER EQUIPMENT IS EASY TO INSTALL. HERE MEN LOWER MAIN SWITCHGEAR SECTION INTO PLACE.**

# G-E load-center power system



Like many other growing plants, the Gardner Board and Carton Co. found they needed more power. They realized, too, a pressing need for more protection against power-failure shutdown than they had with their old-type 480-volt distribution system.

**How they did it:** With the help of General Electric engineers, Gardner completely replaced their old 480-volt system with a modern 4160-volt G-E load-center system. Compact, metal-enclosed unit substations now give them plenty of power—and plenty of protection against power shutdowns too. A secondary-selective system provides duplicate sources of power for substations supplying the most vital plant loads. Metal-enclosure of all live parts—and modern breakers with plenty of interrupting capacity—give further protection both for production and for plant personnel.

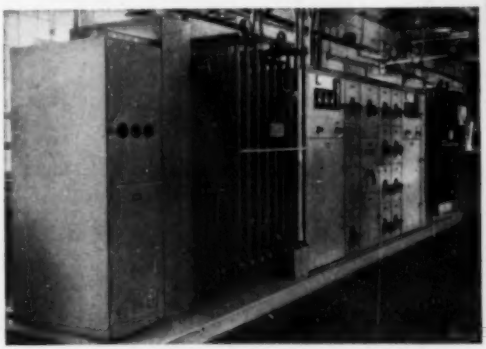
**Improves Voltage—Saves Copper—Flexible for Future**

By taking high-voltage power directly to load centers, long secondary circuits are avoided, and plant voltage improved. The tons of extra copper that would have been required to expand the old 480-volt system were saved. And the plant electric system now has great flexibility for the future. Additional substations can be added easily, quickly, economically. Existing ones can be easily moved to follow load shifts.

For further information on G-E engineered load centers, call on your local G-E sales representative, or write for GEA-3592, General Electric Company, Schenectady 5, N. Y.

***G-E "Project Co-ordination" praised by Chief Engineer***

"Many costly man-hours were saved for us by G-E over-all co-ordination," says Arthur Harvey, Chief Engineer of Gardner Board and Carton Co. "From planning to final installation, G.E. co-ordinated all equipment and delivery details whereas Gardner men installed the equipment. The effect on our production during this period was negligible." In photo above, Mr. Harvey discusses over-all plan submitted by General Electric with Mr. J. M. Popp, G-E sales engineer. A simple outline of this plan is shown in chart on opposite page.



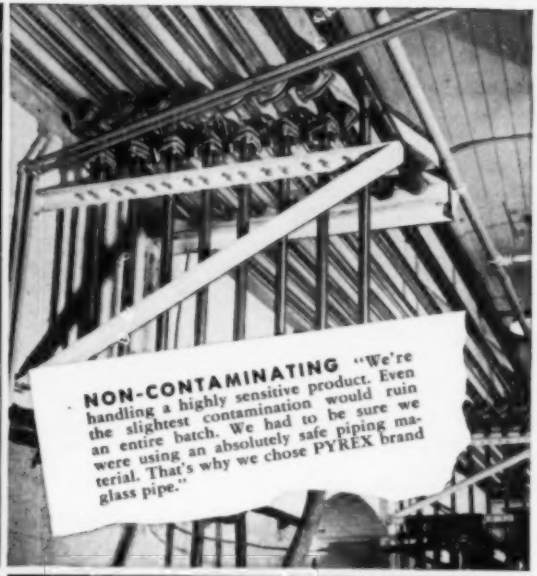
Compact Double-ended Load-Center Unit installed close to load. Ratings: 3000 kva, 4160/480 v. Drawout breakers are easy to inspect, have plenty of interrupting capacity. Note G-E "Interlocked Armor" cables, which provide metal-enclosed circuits with lower material and installation costs.

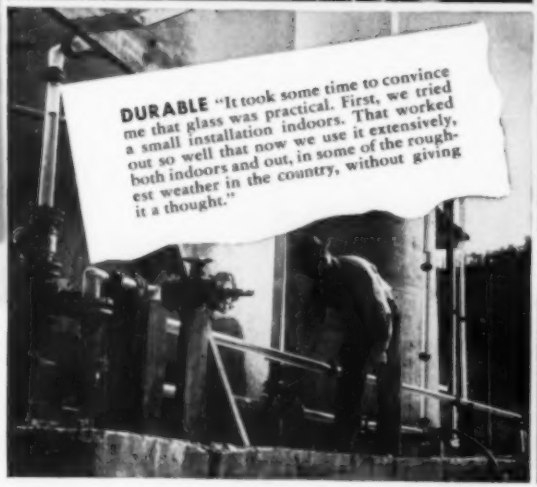
**GENERAL ELECTRIC**

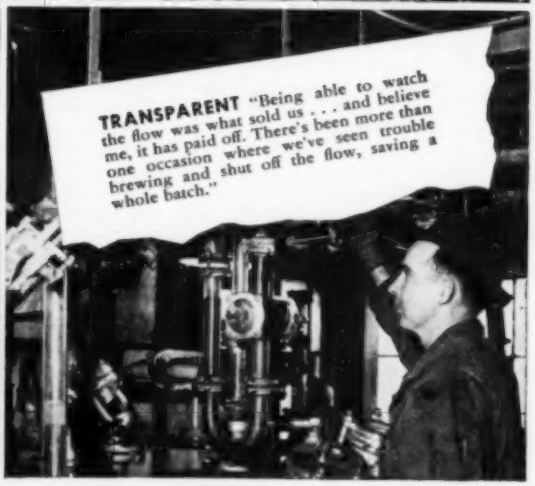
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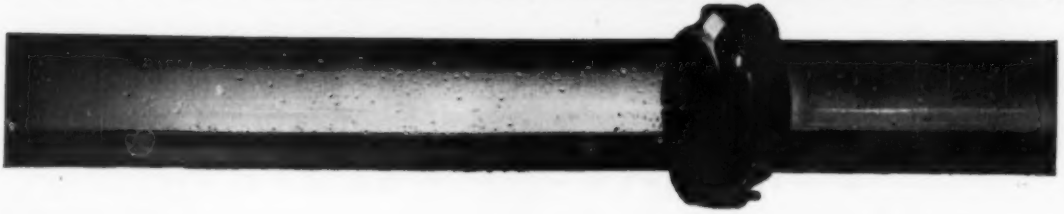
# Why more chemical processors



# are switching to PYREX® brand "DOUBLE-TOUGH" Glass Pipe

Here are 6 reasons why chemical engineers and processors who have had experience with PYREX brand "Double-Tough" glass pipe recommend it to you:

**1.** Highly resistant to corrosion, physical and thermal shock, PYREX pipe lasts longer . . . assures fewer production shutdowns, lower maintenance and replacement costs.

**2.** PYREX brand glass pipe is noncontaminating—protects even the most sensitive solutions.

**3.** Trouble can't hide behind transparent glass pipe. And its smooth surface makes cleaning easy. It can be sterilized with steam.

**4.** Costs less per foot installed than any other corrosion-resistant piping material.

**5.** Easy to install and plumb, your own plant help can put in your PYREX pipe installation.

**6.** PYREX brand "Double-Tough" glass pipe is available now in diameters of 1", 1½", 2", 3", 4" and 6" I.D. in standard lengths up to 10 feet. Fittings include 45° and 90° elbows, tees, reducers and crosses. Plug valves are available in 1" and 1½" sizes. For the complete story, check and mail the coupon . . . or contact the PYREX brand glass pipe distributor nearest you:

**ALBANY 5, NEW YORK** — A. J. Eckert Company
**BELMONT, CALIFORNIA** — Glass Engineering Laboratories
**CAMBRIDGE 39, MASS.** — Macalaster Bicknell Company
**CHICAGO 44, ILLINOIS** — Fred S. Hickey, Inc.
**FRESNO 17, CALIFORNIA** — Valley Fdy. & Mach. Works
**HATBORO, PENNSYLVANIA** — Sentinel Glass Company
**ROCHESTER 3, NEW YORK** — Will Corporation
**HOUSTON 7, TEXAS** — W. H. Curtin Company
**PITTSBURGH, PA.** — Fisher Scientific Company
**MONTREAL 3, QUEBEC, CAN.** — Fisher Scientific Company
**SEATTLE 4, WASHINGTON** — Scientific Supplies
**ST. LOUIS 2, MISSOURI** — Stemmerich Supply Inc.
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## OTHER PYREX brand GLASS PRODUCTS FOR THE PROCESS INDUSTRIES



**PYREX brand Glass Fractionating Columns Offer:**

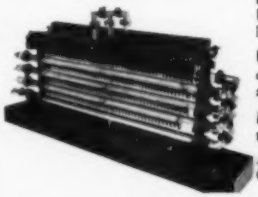
Uniform quality of distillate through elimination of product contamination.

Longer service life because of exceptional resistance to acid corrosion.

High efficiency with a wide range of solvents plus complete visual check on performance.

Sizes: 4", 6", 12" and 18" diameters. Available now at reasonable cost.

**PYREX brand GLASS CASCADE COOLERS GIVE YOU:**



**Low first cost** per BTU transferred besides increased economy through long service life.

**Unusual versatility of mounting** on floor, wall or ceiling to save valuable space.

**Maximum heat transfer** through thin but sturdy walls.

Available now at reasonable cost. Check and mail the coupon.

**CORNING GLASS WORKS, CORNING, N. Y.**

*Corning means research in Glass*

**VISIT THE NEW CORNING GLASS CENTER**

**CORNING GLASS WORKS**

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Please send me the printed information checked below:

- ☐ "PYREX brand Glass Pipe in the Process Industries" (EA-1)
- ☐ "PYREX brand "Double-Tough" Glass Pipe and Fittings" (EA-3)
- ☐ "Plant Equipment Glassware for Process Industries" (EB-1)
- ☐ "Installation Manual" for PYREX brand "Double-Tough" Glass Pipe (PE-3)
- ☐ "PYREX Cascade Coolers" (PE-8)

Name_____

Title_____

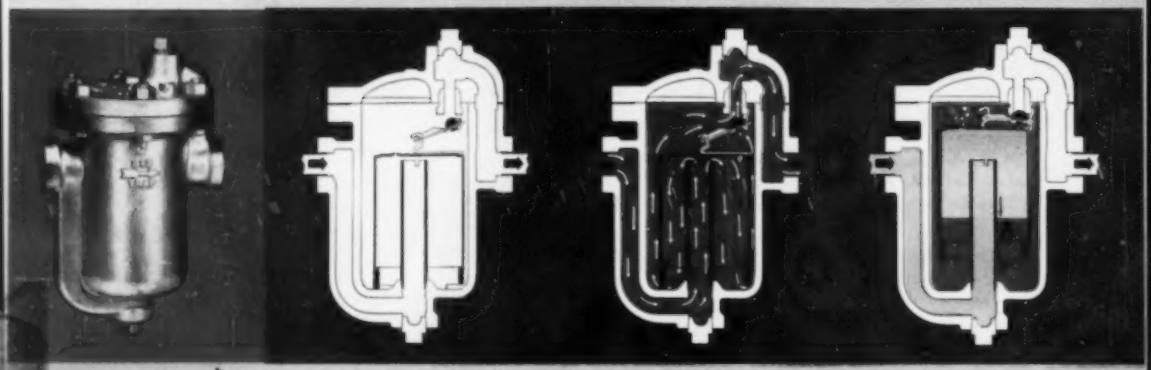
Company_____

Street_____

City_____

Zone_____ State_____

# ARMSTRONG TRAPS are



**A WORKING PICTURE OF ARMSTRONG DESIGN**

**1.** When trap is first installed, the inverted bucket is down and the valve is wide open.

**2.** When steam is turned on, condensate (solid color) flows into trap and out through discharge orifice, until . . .

**3.** steam (light color) reaching the trap floats the inverted bucket and closes the valve.

THE highly efficient design of modern Armstrong traps directly reflects over 40 years' experience in inverted bucket trap manufacture and application gained since Armstrong developed the first practical inverted bucket trap in 1911.

*Armstrong design offers:*

- A "frictionless" leverage system which combines high leverage with wide opening of a large orifice.
- A minimum of parts.
- Strong, corrosion-resistant and wear-resistant materials.
- Generous margins of safety.

*For trap users this means:*

- Large capacity.
- Dependable service under adverse operating conditions.
- Low maintenance.
- Continuous operation of heating and process equipment.

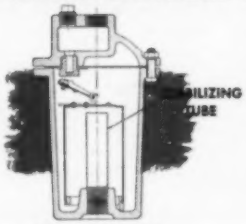
The soundness and benefits of Armstrong design have been proved in thousands and thousands of plants all over the world. To insure dependable condensate drainage for a new plant or plant expansion, simply specify: "Traps shall be Armstrong." For additional information, call your local Armstrong Representative or write:

**ARMSTRONG MACHINE WORKS**
858 Maple St., Three Rivers, Michigan

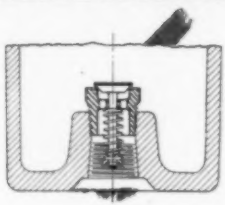
**SELF-SCRUBBING ACTION** (see Fig. 2 above). Note that condensate first flows down between bottom of bucket and trap body, then up and out through orifice. The high velocity flow under bottom of bucket keeps dirt in suspension, washes it out when trap opens. No dirt problems with Armstrong design.

**BUCKET FLOATS WHEN LESS THAN ⅔ FULL OF STEAM** (see Fig. 3 above). The generous margin of safety (dimension A in Fig. 3 above) insures that the bucket will float with trap body partly full of water. A heavier bucket would give more power but it might not float and close the valve.

## SOME OTHER ARMSTRONG




**STABILIZING TUBE**
Condensate, air and steam are admitted above water level in trap bucket. The water level is undisturbed, eliminating wear-producing agitation of the bucket, valve lever and valve. This exclusive feature greatly lengthens life of working parts.

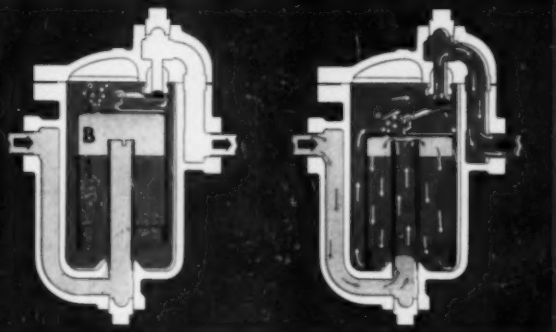


**INTERNAL CHECK VALVE**
All Armstrong traps can be equipped with the Armstrong spring-loaded stainless steel check valve. Costing less than an external check valve, it also saves installation labor and fittings.

ARMSTRONG · INVERTED BUCKET · STEAM TRAP

# ARMSTRONG

# Designed to give better Performance!

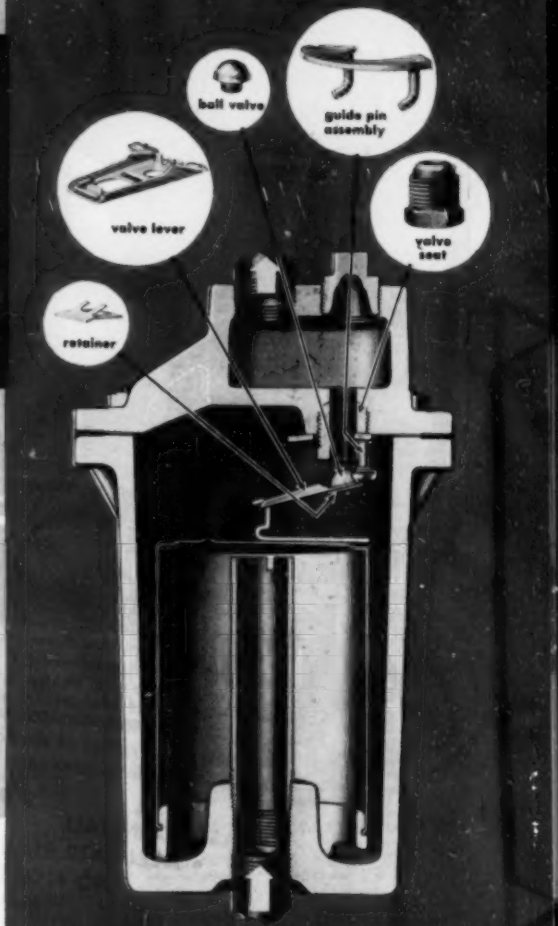



**4.** When more condensate enters the trap, the bucket loses buoyancy and pulls on valve lever.

**5.** When weight of bucket times leverage overcomes pressure on valve, bucket sinks and opens trap.

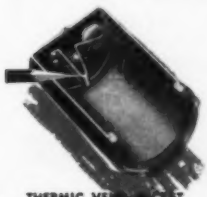
**NO AIR BINDING** (see Fig. 4 above). Air mixed with steam passes through the bucket vent, collects at top of trap and is discharged ahead of condensate. The large air-handling capacity of Armstrong traps insures top equipment temperatures and faster heat-up.

**EXCESS POWER PROVIDED FOR OPENING TRAP** (see Fig. 5 above). Weight of bucket times leverage opens trap. Here again Armstrong design provides a generous safety margin. Reducing dimension B in Fig. 4 would increase power of bucket but margin between test opening pressure and operating pressure would be too low to allow for normal wear and for pressure fluctuations.

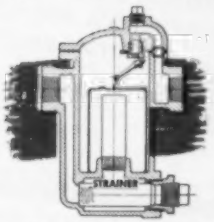



Cross-section Armstrong favored outlet bottom inlet — top outlet trap.

## TRAP DESIGN FEATURES



**THERMIC VENT BUCKET**
Where large amounts of air must be discharged when steam is turned on, and where air can be pushed out ahead of incoming steam, this bucket will speed heat-up greatly. The vent is open when trap is cold, closes at 210° F. Has 50 to 100 times air handling capacity of standard buckets.




**INTEGRAL STRAINER TRAPS**
The two smallest sizes of Armstrong traps, most apt to need strainer protection, are available in a body style having the strainer built right in. The strainer can be cleaned while trap is operating.

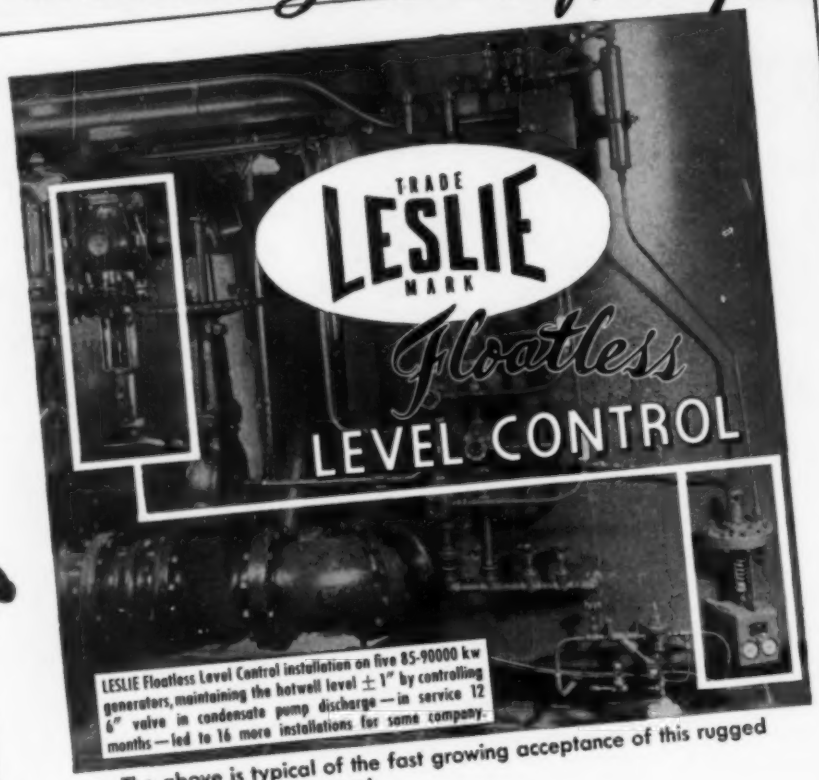
**SEND FOR *NEW***
**44-PAGE STEAM TRAP BOOK**

Complete data on Armstrong trap design and operation; physical data and list prices; capacities; selection, installation and maintenance recommendations. Free on request.




# STEAM TRAPS

# An Outstanding Record of Acceptance!




LESLIE Floatless Level Control installation on five 85-90000 kw generators, maintaining the hotwell level ± 1" by controlling 6" valve in condensate pump discharge — in service 12 months — led to 16 more installations for same company.

The above is typical of the fast growing acceptance of this rugged and accurate level control.

**ADVANTAGES**

- EASY TO INSTALL
- ACCURATE REGULATION (± 1" Water Column)
- NO FLOATS, STUFFING BOXES, ETC.
- MULTI-MEDIUM ACTUATED
- DIAPHRAGM PRESSURE ELEMENT
- ACTION REVERSIBLE

**Applications:** On open and pressurized vessels, including boilers, tanks, evaporators, heaters, standpipes, etc.

PRINTED IN U.S.A.

*SEND for* **illustrated Bulletin**

Look for LESLIE Regulators under "Valves" or "Regulators" in your Classified Telephone Directory in leading industrial cities where LESLIE factory-trained engineers are located.

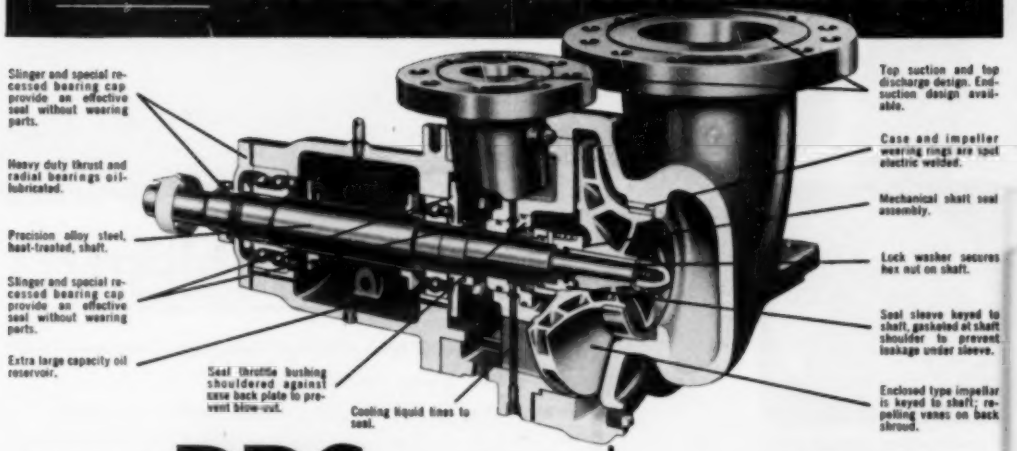
**LESLIE CO.,** 279 Grant Avenue, Lyndhurst, New Jersey

1827

PRESSURE REDUCING VALVES • PRESSURE CONTROLLERS • FLOATLESS LEVEL CONTROLS
PUMP GOVERNORS • TEMPERATURE REGULATORS
SELF CLEANING STRAINERS • AIR HORNS • STEAM WHISTLES

# First FROM PEERLESS

## A HEAVY DUTY REFINERY & CHEMICAL PROCESS PUMP DESIGNED *WITH AND FOR* A MECHANICAL SHAFT SEAL




## PEERLESS type PRS PROCESS PUMP

The Peerless Type PRS pump is designed *specifically* for mechanical shaft seal construction. All the advantages of proved mechanical seals are inherent in the Type PRS pump design.

**1. LONGER LIFE.** Mechanical seal design permits use of short shaft. A shorter shaft means greater rigidity, less deflection, minimum run-out, less wear in bearings, wear rings, seal and moving parts.

**2. GREATER SAFETY.** Throttle bushing is shouldered against case back plate from suction side; cannot blow out even under maximum operating pressure.

**3. MORE ECONOMICAL.** No premium is charged in first cost for the mechanical shaft seal construction of the Type PRS pump. Lower maintenance costs will be effected throughout its longer life.

**4. AVAILABLE IN SEVERAL SIZES.** Peerless Type PRS pumps are available for quick assembly and shipment from Peerless' Los Angeles stock in several sizes.

**5. ENGINEERING CONSULTATION SERVICE.** Help on selection and application of the Type PRS pumps to your problems is available from the Peerless factory or the Peerless field engineer or distributor nearest you.

PEERLESS PUMPS

### Characteristics AT A GLANCE

| | |
|---|---|
| Capacities | up to 1000 gpm |
| Operating Heads | up to 625 feet |
| Case Pressures | up to 400 psig |
| Temperatures | up to 250° F |
| Drives | horizontal electric motor is standard; other types available as required. |

### APPLICATIONS

Use the Peerless Type PRS pump for handling all petroleum hydrocarbons, process liquids, water, hot oil, LP-gases. Liquid end can be furnished in material suitable to the intended service.

PEERLESS BUILDS *Dependable* PUMPS

PEERLESS PUMPS

***Write or wire today for further engineering information.***

fmc

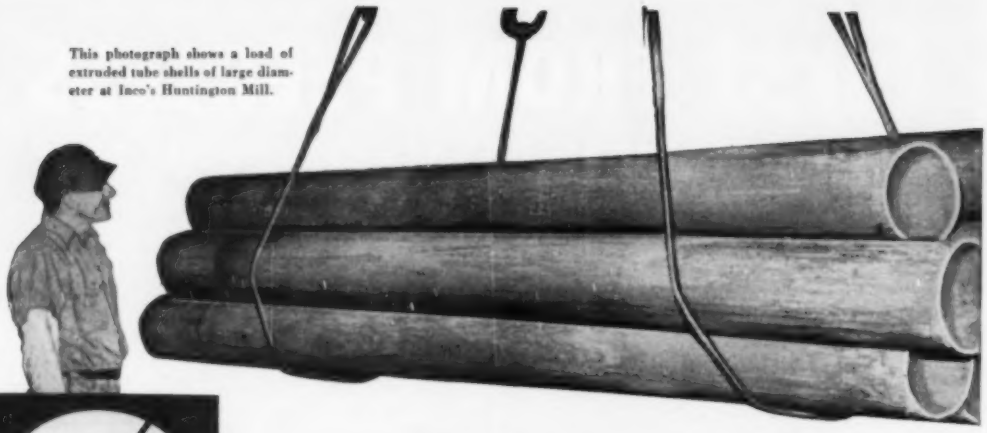
**PEERLESS PUMP DIVISION**

**FOOD MACHINERY AND CHEMICAL CORPORATION**

*Address inquiries to Factories at:*

**Los Angeles 31, California and Indianapolis 8, Indiana**

Offices: New York, Chicago, St. Louis, Atlanta; Dallas, Plainview and Lubbock, Texas; Fresno, Los Angeles, Phoenix, Albuquerque, N. M.; Tulsa



This photograph shows a load of extruded tube shells of large diameter at Inco's Huntington Mill.



Smallest tube in the world. Photographed in comparison with a fly's wing, this pure Nickel tube is only 0.0014" in outside diameter. Produced by Superior Tube Co., Norristown, Pa.



Corrosion-resisting Nickel Alloy pipe and tube fittings . . . representative of the extensive line available.

# Tubing Problem?

## INCO Nickel Alloy Tubing and Fittings

### Range of Sizes

| | | | |
|---|---|---|---|
| **Seamless tubing and condenser tubing** | **Alloy** | **O.D. Tubing** | **Wall** |
| | Monel | ½" to 8¼" | 0.025" to 0.500" |
| | Nickel | ½" to 8¼" | 0.025" to 0.500" |
| | Low-Carbon Nickel | ½" to 8¼" | 0.025" to 0.500" |
| | Inconel | ½" to 6" | 0.035" to 0.259" |
| | Incoloy | ½" to 6" | 0.035" to 0.259" |
| **Extruded tubing** | **Alloy** | **O.D.** | **Wall** |
| | All alloys | 2½" to 9¼" | ¼" to ⅝" |
| **Seamless pipe** | **Alloy** | **Iron Pipe Sizes** | |
| | Monel | ⅛" to 8" | Made in Schedules 5-10-40-80 |
| | Nickel | ⅛" to 8" | |
| | Low-Carbon Nickel | ⅛" to 8" | |
| | Inconel | ¼" to 6" | |
| | Incoloy | ¼" to 6" | |
| **Small diameter tubing** | **Alloy** | **O.D.** | **Wall** |
| | All alloys | 0.012" to 0.625" | 0.0015" to 0.010" |
| **Fittings:** | **Alloy** | **Size** | |
| Cast threaded | All alloys | Made in Iron Pipe Sizes ⅛" to 6" | |
| Wrought welded | All alloys | Sizes: ½" to 12" | |

## Distributors of INCO Products, U. S., Canada, Mexico

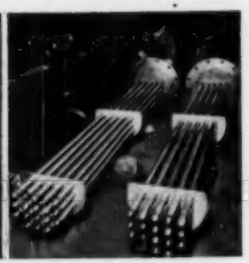
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Baltimore 3—Whitehead Metal Products Co., Inc.
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Cambridge 39, Mass.—Whitehead Metal Products
Chicago 23—Steel Sales Corporation
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Cleveland 14—Williams and Company, Inc.
Columbus 8, Ohio—Williams and Company, Inc.
Dallas 9—Metal Goods Corporation
Denver 2—Metal Goods Corporation
Detroit 10—Steel Sales Corporation
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Grand Rapids 2—Steel Sales Corporation
Harrison, N. J.—Whitehead Metal Products Co., Inc.
Houston 3—Metal Goods Corporation
Indianapolis 2—Steel Sales Corporation
Kansas City 8, Mo.—Steel Sales Corporation
Los Angeles 21—Pacific Metals Company, Ltd.
Mexico, Mexico, D.F.—La Paloma Co. De Metales, S.A.
Milwaukee 9—Steel Sales Corporation
Minneapolis 13—Steel Sales Corporation
Montreal 1, Que.—Robert W. Bartram, Limited
New Haven 13—Whitehead Metal Products Co., Inc.
New Orleans 12—Metal Goods Corporation
New York 14—Whitehead Metal Products Co., Inc.
Philadelphia 40—Whitehead Metal Products Co., Inc.
Pittsburgh 33—Williams and Company, Inc.
Portland 12, Ore.—Eagle Metals Company
St. Louis 10—Steel Sales Corporation
Salt Lake City 4—Pacific Metals Company, Ltd.
San Diego 1—Pacific Metals Company, Ltd.
San Francisco 10—Pacific Metals Company, Ltd.
Seattle 4—Eagle Metals Company
Spokane 8—Eagle Metals Company
Syracuse 4—Whitehead Metal Products Co., Inc.
Toledo 2—Williams and Company, Inc.
Toronto 5, Ont.—Alloy Metal Sales, Limited
Tulsa 3—Metal Goods Corporation
Vancouver, B. C.—Wilkinson Company, Ltd.





**PURITY MAINTENANCE**

Nickel's corrosion resistance to caustics makes it ideal for this patented spiral flight caustic cooler. It safeguards the purity of caustic soda, so necessary in rayon, cellulose film, soap, etc., manufacture.



**EXCELLENT HEAT TRANSFER**

Nickel tubes provide efficient heat transfer in steam-heating kettles handling an organic chemical. Nickel resists scale formation, corrosive attack, erosion and pitting. It makes for faster, more economical operation.

# Try These For Size

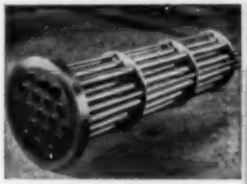
**Whether you need a tube of hairlike fineness or large diameter, you'll find it regularly produced in Inco Nickel Alloys.**

Wherever conditions demand corrosion resistance, purity maintenance, excellent heat transfer, strength or high temperature resistance (as these examples illustrate) there's an Inco tube size to solve the problem.

Today, however, Nickel and Nickel Alloys are on extended delivery. Therefore, it pays to anticipate needs. When you order tubing, pipe or fittings, order well in advance of work schedules. And always give NPA rating and complete end-use information.

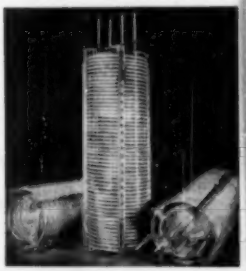
Also consult your local Inco Distributors for helpful information and assistance. For a handy reference, cut out and file the opposite page. It indicates the range of sizes in which Inco Alloy tubing may be obtained.

For more details send for Technical Bulletin T-17. Write today! Address your nearest Distributor of Inco Products.



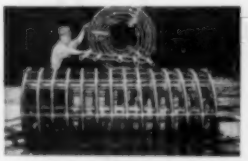
**CORROSION RESISTANCE**

This Monel® tube bundle used in an HF Alkylation Unit Dehydrator Reboiler is an excellent example of Monel's high resistance to corrosive chemical attack even at high operating temperatures and pressures.



**STRENGTH**

Designed for a working pressure of 3500 p.s.i. at 600° F., Inconel coils like these are integral parts of many chemical processing units. The inherent strength of Inconel makes it ideal for high pressures and temperatures.



**HIGH-TEMPERATURE RESISTANCE**

These coils, made of Inconel tubing, operate at temperatures as high as 1300° F. And they maintain their corrosion and erosion resistance against chemical attack despite the vigorous operating conditions.

**THE INTERNATIONAL NICKEL COMPANY, INC.**

67 Wall Street, New York 5, N. Y.

**Nickel** (INCO) **Alloys**

MONEL® • "R"® MONEL • "K"® MONEL
"KR"® MONEL • "S"® MONEL • NICKEL
LOW CARBON NICKEL • DURANICKEL® • INCONEL®
INCONEL "X"® • INCOLOY • NIMONICS

# BUILDING FURNACES?



**LOW HEAT CAPACITY** is an inherent property of ALFRAX BI aluminum oxide refractory. It's literally made of bubbles — hollow spheres of $Al_2O_3$, specially bonded together. It has good load strength, is an exceptional insulating material for jobs over 3000F. Also available as a castable cement. Just mix with water and handle like Portland cement.

# SHORT ON

*here's help*

**How to keep shortages of certain critical alloys and refractories from delaying furnace construction.**

For want of certain scarce heat resisting metals or special duty refractories, many furnaces nowadays get nine-tenths built . . . then wait for the scarce materials. Surprisingly often, this delay could be avoided by substituting our Super Refractories. These materials *are available*. They do have the properties needed. And they'll generally outperform the metals or refractories they replace, *at a lower final cost*.

Consider metals, for example — how do Super Refractories compare? To begin with, they are generally very strong. (The

***Use Super Refractories by***

**CARBORUNDUM**

Trade Mark

Refractories Division — The Carborundum Company, Perth Amboy, N. J.

*"Carborundum", "Carbofrax", "Mullfrax" and "Alfrax" are registered trademarks which indicate manufacture by The Carborundum Co.*



**ALLOY REPLACEMENT** is an important function of our CARBOFRAX silicon carbide refractories. These unusual materials often double for furnace parts made of chrome, nickel or cobalt alloys, such as skid rails, muffles, roller hearths, radiant tubes, brazing fixtures, etc. They not only outlast metals, but can also increase the capacity of your equipment.



**MULLITE** refractories of certain types are often hard to get. However, the purest of the mullites — MULLFRAX electric furnace mullite — is still available. Made by melting together exact proportions of high purity raw materials, it is an entirely synthetic product. Hence, it is purer and more refractory than mullite obtained from natural sillimanite. Note, in the test above — five hours at 3000F — that the MULLFRAX brick ("M") is the only one of these four commonly used refractories, untouched by the heat.

# MATERIALS?

modulus of rupture of one Super Refractory averages 3100 psi at 2460F). Most important, they *retain their strength* at temperatures where metals are unusable. All Super Refractories can be safely used considerably above 2800F, whereas 25-12 chrome-nickel steel loses strength rapidly over 1500F, is unsafe over about 2100F.

Some Super Refractories are also more resistant to abrasion than metals, particularly at furnace temperatures. In fact, they are the *toughest known materials* for large scale use. Super Refractory hearths, skid rails, etc. distinctly outwear their alloy counterparts.

Muffles, hearths, radiant tubes and other indirect-heating furnace parts, which must transfer heat rapidly, are often made of Super Refractories. *One Super Refractory conducts heat almost as rapidly as chrome nickel steels!*

You'll find our Super Refractories, too, where chemical attack is severe. They're used in muriatic acid furnaces, hydrogen cyanide converters — even as spray nozzles for sulfuric acid.

There's another Super Refractory that has good insulating quality, particularly at temperatures over 3000F. This material makes an excellent low-heat-capacity lining, for either facing or backing up purposes.

In fact, for practically any combination of furnace conditions — high heat, heat shock, flame impingement, etc. — there's usually a Super Refractory to fit the job . . . and do it better. So don't wait until scarce materials get scarcer. Check up on Super Refractories now. Remember, it's not the first, but the *last cost* that counts — and an unfinished furnace becomes increasingly costly. Write or call us today.

**Practically all Super Refractories are available as cements, bricks, or special shapes moulded to close tolerances — including fitted joints, tubes, etc. Information is available on the principal properties of all major compositions. Just send the coupon for our free booklet.**



**Dept. H-62**
**Refractories Div., The Carborundum Co.**
**Perth Amboy, New Jersey**
Please send your free booklet on properties of Super Refractories.

**Name**_____

**Position**_____

**Company**_____

**Street**_____

# HOW MUCH DO FILTER

Have you ever thoroughly investigated both the direct and indirect cost of filter cloths in your plant? If not, the chances are you will be surprised to find that annual cloth replacement and maintenance cost alone runs from $1.00 to $4.00 per square foot of press area per year, depending on the utilization of your press, the product and the type of fabric you use.

Other costs associated with use of cloths, such as the labor for scraping, handling, washing; breaking and redressing the press; and purchasing time expended in obtaining the cloth you need when you need it will probably be even greater, even if not as easily pinned down.

Here then are three immediate reasons why you should consider switching to modern high-speed Niagara pressure leaf filters:

**1. Niagara filters require no filter cloths.** Accurate case histories in our files show that some plants amortize their Niagara filters in a few years on this saving alone.

**2. Niagara filters require less labor.** When you eliminate filter cloths, you eliminate the back-breaking and costly labor that goes with them. With Niagaras you get a quick, easy, clean operation that takes only a few minutes for one man between cycles.

**3. Niagara filters work harder for you.** Reduced downtime means more production time and therefore higher production at your filter station. The filter works for you more hours per day—gives you many more gallons throughput with less installed filter area.

●

By switching to Niagaras, many press users have realized over-all savings that amortize the cost of the new filters in months.

Entirely aside from savings, here are nine sound reasons for installing Niagara Filters:

**1. Higher flow rates** on an equal area basis. Niagaras normally give flow rates 2 to 5 times those of conventional cloth-covered filter presses. This is because the rigid metal screens do not "give" under pressure—cannot obstruct flow channels in the drainage member as does sagging fabric cloth.

**2. Sparkling filtrate clarity.** Positive removal of solids to practically any degree of clarity you desire. In sanitary applications, 0-0 bacteria count can usually be secured in one filtration.

**3. No leakage.** Fully enclosed, pressure-tight construction eliminates drippage and fumes. Ideal for handling flammable, explosive, toxic, volatile, or highly obnoxious liquors.

**4. Excellent cake-washing characteristics.** Nearly true displacement washing is obtainable. Wash liquid is a minimum.

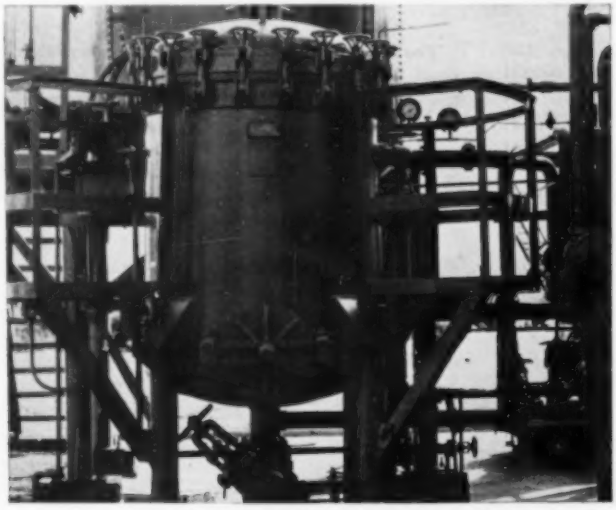
**5. One-man operation and cleaning.** Single or multiple units can be operated and cleaned easily by one man. The entire leaf battery is accessible for easy cleaning.

**6. Corrosion resistance.** The pressure leaf filter can more cheaply and readily be constructed of stainless steel, nickel, monel and other corrosion-resistant materials.

**7. Jacketed construction.** Niagaras can readily be supplied with steam jackets or special insulation.

**8. Wide capacity range.** Sizes range from 20 to 950 square feet of filter area, with average capacity of 10 to 425 G.P.M. in one compact unit. (Even larger areas are available in the new horizontal filter shown at right on the opposite page.)

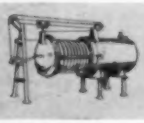
**9. Lower maintenance cost.** There are no moving parts during filtration. Simple construction, with fewer parts to wear out, means low-cost upkeep.



THIS NIAGARA FILTER, in large petrochemical plant, removes iron sulfide particles from solutizer solution.



Niagara Filter CORPORATION



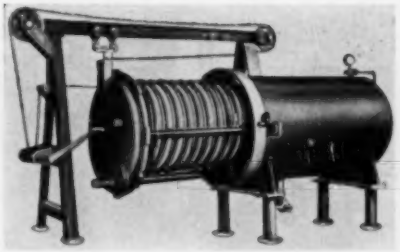
HORIZONTAL for non-aqueous liquids; high solids; cake recovery.

IN EUROPE—NIAGARA FILTERS EUROPE, 36 Leidsegracht, Amsterdam-C, Holland

# CLOTHS COST YOU?

## NEW NIAGARA STYLE H* FILTER

### Low cleaning time . . . no cloth cost



This new Niagara filter answers the need for a filter which can quickly discharge large quantities of semi-dry cakes. A variation of the standard Niagara design, it still retains all the basic advantages of Niagara vertical pressure leaf filters.

A retractable carriage permits all leaves to be withdrawn at once for rapid cleaning. One man can easily discharge as much as 150 cu. ft. of semi-dry cake in a matter of minutes merely by rapping the leaves.

A new closure design, the Q/O* (quick-opening) cover, permits faster, easier opening and closing than ever before in a filter of this size.

The Style H filter, available in sizes up to 1500 sq. ft., is ideal for filtration where high percentages of solids must be removed or where solids must be recovered. It is also recommended for standard liquid clarification where low headroom or other special reasons make its horizontal construction preferable to a vertical filter.

*Trade Mark Patent Applied For.

## HOW THE NIAGARA FILTER WORKS

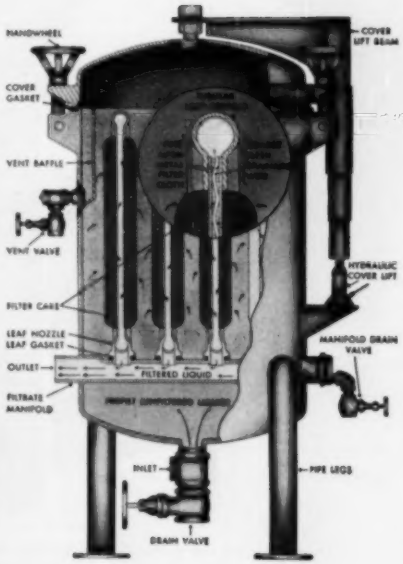
The leaves, which are the heart of the filter, consist of double-faced screen assemblies bounded by a tubular drainage frame leading to an outlet nozzle.

The unfiltered liquid usually with filteraid in suspension is pumped into the closed pressure filter tank in which the leaves are placed, and is forced through the fine-mesh screens, on which the filter cake is formed by the solids in the liquid.

Only the clear liquid reaches the inside of the leaves, flowing through the coarse center drainage wire to the tubular frames, and out through the leaf nozzles to the manifold.

When the batch has been completely filtered, or when the cake has nearly filled the space between the leaves, the filter is emptied and the filter cake is sluiced from the leaves with a hose or with automatic high-pressure sprays. Sluicing is done without removing any parts from the filter. (Cake removal for the Style H filter is somewhat different, as described above.)

As a rule, the filter is ready to go to work again in 15 minutes to one hour, depending on its size.




### THESE 5 SERVICES HELP MAKE HIGH-SPEED, LOW-COST FILTRATION A REALITY IN YOUR PLANT:

**1. Nationwide field service.** Niagara representatives in 24 cities know filtration and can give you facts.

**2. Modern filtration laboratory** determines your requirements accurately by test-filtering samples of your materials.

**3. Pilot filter rental** plan enables you to "preview" Niagara performance in your plant, at low cost.

**4. Custom engineering.** A single filter or a complete system, designed for your needs and built in materials of your choice.

**5. Installation and start-up** are supervised by Niagara factory engineers, always on call.



PILOT FILTER duplicates operation of large production models.

Operating figures prove the economic soundness of replacing cloth-covered presses with Niagara filters. For details, write us today. Or mail the coupon for descriptive literature.



STANDARD VERTICAL — for clarification and "polishing".



"AUTO-SLUICE" for fully automatic cake sluicing.

**NIAGARA FILTER CORP., 3687 Main St., Buffalo 14, N. Y.**

Please send: ☐ General literature; ☐ Data on horizontal filters; ☐ Data on pilot filter rental

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State____

# let's take a CLOSER LOOK at STRESS RUPTURE



In evaluating the suitability of various tubes for high pressure, high temperature applications, consideration of their stress-rupture properties is of major importance to avoid misapplication and consequent possibility of costly service failures.

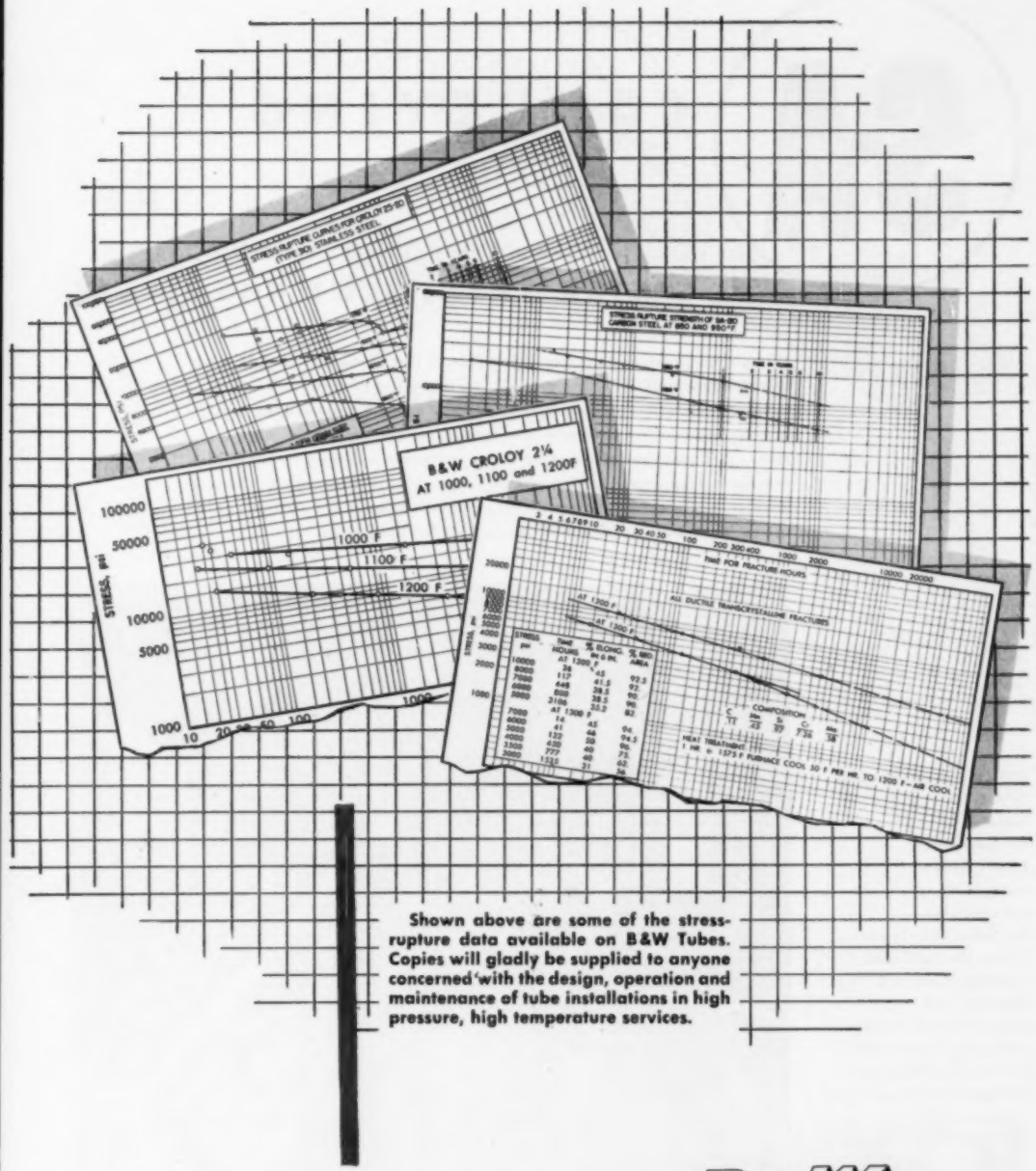
B&W's long experience with tubing applications in the petroleum and chemical processing industries, where stress and temperature conditions often are acute, has led B&W to conduct complete, analytical stress-rupture tests far exceeding conventional practice so as to answer the most exacting questions of tube applications in modern processing conditions.

In essence, the stress-rupture test is an overloaded creep test which is continued to actual failure of the specimen. Destructive testing of this kind acknowledges theoretical approach, but at the same time circumvents it by simulating the worst possible conditions that would likely be encountered in actual service. Through such long-term tests extrapolation is reduced to the minimum with the result that possibility of error in determining stress-rupture limits of tubing materials is minimized.

From curves like those on the opposite page and other available stress-rupture data, it is possible to closely determine: (1) the amount of extension, or elongation, various metals will stand under given stress and temperature conditions before rupture occurs, (2) how long various metals can be overheated under given stress without failing due to rupture.

Investigation of stress-rupture properties of tube-steels is a continuing activity at B&W. Facilities devoted to this purpose are among the most extensive available anywhere.

If rupture strength is your tube problem, consult Mr. Tubes—your B&W Tube Representative. Available through him is a wealth of experience and technical data on the behavior of carbon, alloy, and stainless steel tubes at elevated pressures and temperatures.




**Shown above are some of the stress-rupture data available on B&W Tubes. Copies will gladly be supplied to anyone concerned with the design, operation and maintenance of tube installations in high pressure, high temperature services.**

**THE BABCOCK & WILCOX COMPANY**
***TUBULAR PRODUCTS DIVISION***

*General Offices & Plants*
**Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing**
**Alliance, Ohio—Welded Carbon Steel Tubing**

*Sales Offices:* Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. • Cleveland 14, Ohio Denver 1, Colo. • Detroit 26, Mich. • Houston 2, Texas • Los Angeles 17, Cal. • New York 16, N. Y. • Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Cal. • Syracuse 2, N. Y. Toronto, Ontario • Tulsa 3, Okla.

B&W SEAMLESS and WELDED TUBES

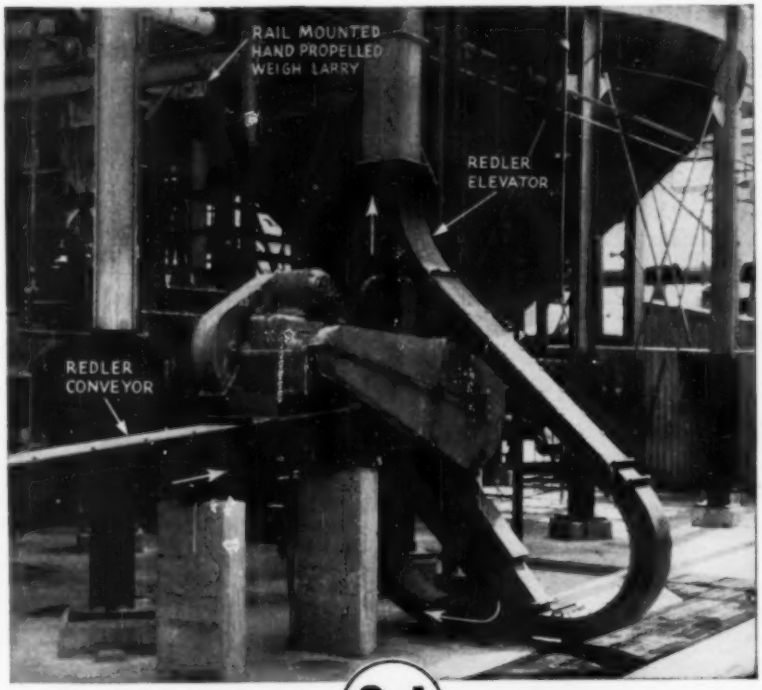
TA-16535

# S-A CONVEYING Systems

## Prove Superior for Handling WATER TREATMENT CHEMICALS

**When the handling of hygroscopic materials must be accomplished without absorption of moisture, even during periods of high humidity—when materials must be moved without spillage and without contamination . . . that's when S-A engineers and equipment prove outstandingly superior! . . . Regardless of *your* particular materials handling problem, S-A engineers draw upon more than half a century of specialized experience—have at their command a complete line of bulk materials handling equipment. Write for complete information . . . no obligation.**

*A REDLER Conveyor with totally-enclosed casing receives water treatment chemicals from a track hopper—conveys them 62 feet to the loop-boot feed section of a REDLER Elevator-Conveyor which lifts them 50 feet to a 54-foot long horizontal run over three storage bins. Materials are reclaimed by an S-A Weigh Larry operating under the bins.*




**REDLER** Conveyor-Elevators
**ZIPPER** Conveyor-Elevators
Vibrating Conveyors
Belt Conveyors
Screw Conveyors
Bucket Elevators
Pan Conveyors
Belt, Pan & Plate Feeders
Circular Bin Dischargers
Centrifugal Loaders & Pilers
Vibrating Screen
**TELLEVEL** Bin Level Controls
Ship Loaders & Unloaders
Crushers, Roll & Ring Type
Storage & Reclaiming Systems
Bin Gates, All Types
**SEALMASTER** Ball Bearing Units

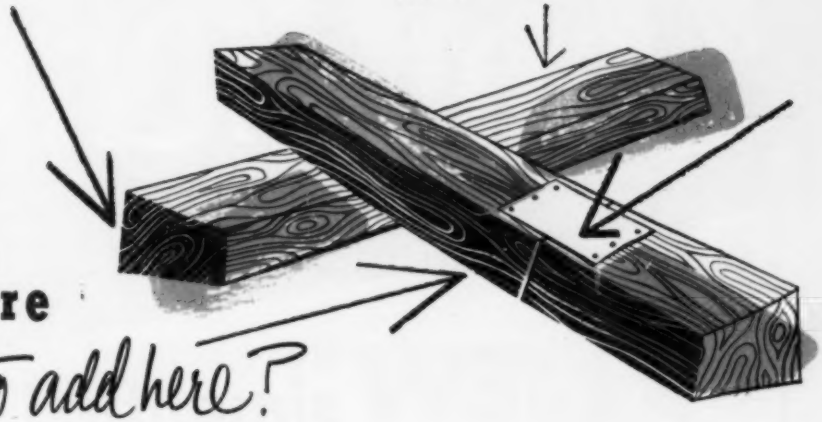
*Write for Bulletins on any of the above*

**STEPHEN S-A DAMSON MFG. CO.**

3 Ridgeway Avenue, Aurora, Illinois — Los Angeles, Calif., Belleville, Ontario

**DESIGNERS AND MANUFACTURERS OF ALL TYPES OF BULK MATERIALS HANDLING EQUIPMENT**

# why cut here *to add here?*



Doesn't make much sense, does it? Yet it happens all the time . . . particularly with inferior steel castings. Sure, the initial cost is likely to be less, but from there on you start piling it up again. Unnecessary handling . . . excessive machining time and always the possibility of finding a defect after part of your machining is done.

Sivyer customers have learned that Sivyer finish . . . clean core holes, accuracy of dimensions, freedom from distortion, absence of waste metal . . . means lower cost conversion, extra dependability.



Specify steel castings bearing the famous Sivyer ◇S◇ . It is worth looking for . . . the soundest kind of economy in the long run.

**SIVYER**

SPECIALISTS IN HIGH ALLOY AND SPECIFICATION STEEL CASTINGS

SIVYER STEEL CASTING COMPANY • MILWAUKEE ◇S◇ CHICAGO ◇S◇

# Simplicity is

## NEW simplified
## Recording Potentiometer
## by WESTON

*built to the same high standards of*
*accuracy . . . sensitivity . . . durability*
*as all instruments bearing this name.*

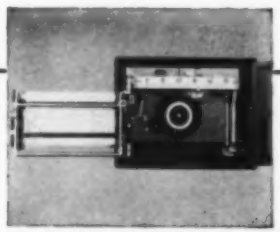


Chart frame swings out full 180° on straight pivots, chart remaining in time sequence. Charts easily installed in matter of seconds.

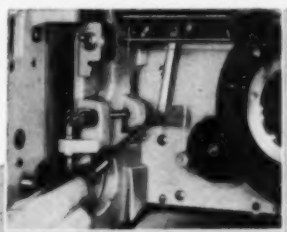
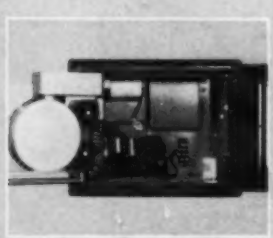


Chart speeds changed by simple screwdriver adjustment. Ranges quickly changed, too, by simply inserting correct range standard.



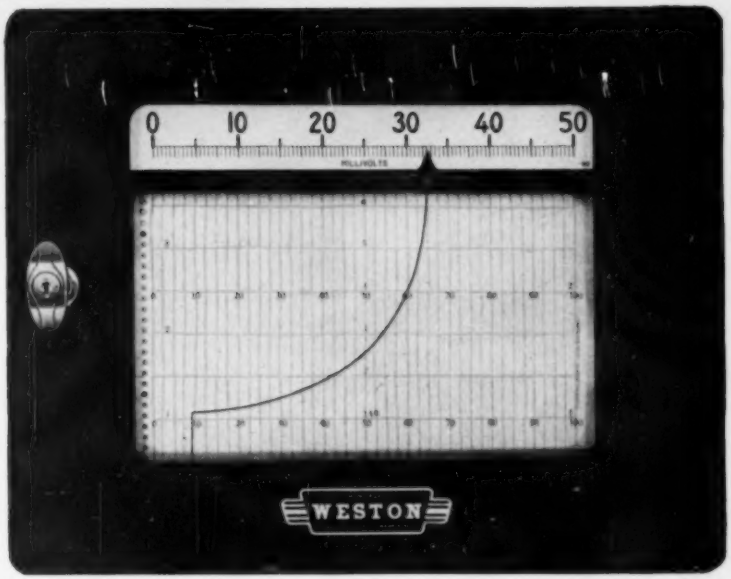
Note extreme simplicity both mechanical and electrical; as well as complete accessibility for quick maintenance and servicing.

WESTON TAG 9120

**WESTON** *Instruments*

INDICATE . . . RECORD . . . CONTROL

# the keynote!




With this new high-speed Recording Potentiometer WESTON sets a new pattern for sound, simplified design . . . for simplicity and economy of maintenance . . . and for sustained high accuracy and sensitivity. With fewer components . . . with all assemblies greatly simplified and quickly interchangeable . . . with all adjustments including range changes made quickly on-the-line . . . with new compactness, ruggedness, and sustained high accuracy . . . this modern instrument will cut costs, and eliminate headaches wherever instrumentation is involved. You will want all the facts. Ask your local WESTON Representative, or write direct . . . WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey . . . *manufacturers of Weston and Tag Instruments.*

**Chart installation is Simpler** — with new accessibility, and no loose parts to handle, chart can be installed in half the usual time. The chart drive has been simplified, made more positive, too.

**Chart speed changes are Simpler** — exclusive multi-speed chart drive permits instant selection of five different speeds with ordinary screwdriver. Speeds doubled or quadrupled by two simple gear changes.

**Changing ranges is Simpler** — you just insert correct range standard and tighten with screwdriver. Reference junction compensation changed in like manner. *No soldered connections used.* Universal slide wire needs no changing.

**Pen and carriage are Simpler** — pen quickly, easily filled without removal, or taking instrument out of service. Pen won't clog, never pumps or syphons-off, needs no priming after initial starting. One-piece pen carriage has oil-less bearings and is driven by woven stainless steel cable.

**New Simplified ruggedness**—all parts amply proportioned for strength and rigidity, to maintain mechanical alignment under tough usage.

**All maintenance is Simpler** — plug-in type amplifier, for example, removed in a jiffy. Liberal use of oil-less bearings reduces lubrication problems. No on-the-job soldering required.

# HEADQUARTERS FOR HEAVY STEEL FORGINGS



STEEL ROLLS

PRESSURE VESSELS



PRESS CYLINDER



RINGS

Whatever your needs for heavy steel forgings in industry, Midvale can assure you of the finest in craftsmanship, precision and ultimate performance. Whether it is weldless gear rings for turbine speed reduction . . . cylinders for hydraulic presses . . . weldless high-pressure vessels for oil refining, gas reactions and steam generation or hardened and ground steel rolls for cold rolling carbon and alloy steel, stainless steel, aluminum, copper, brass, zinc, foil, paper, linoleum, plastics and rubber . . . Midvale engineers can help you design them. Midvale craftsmen, with the most modern equipment, will build them to your most exacting specifications. Put your heavy forging problems in our hands.

**THE MIDVALE COMPANY**

NICETOWN, PHILADELPHIA, PENNA.

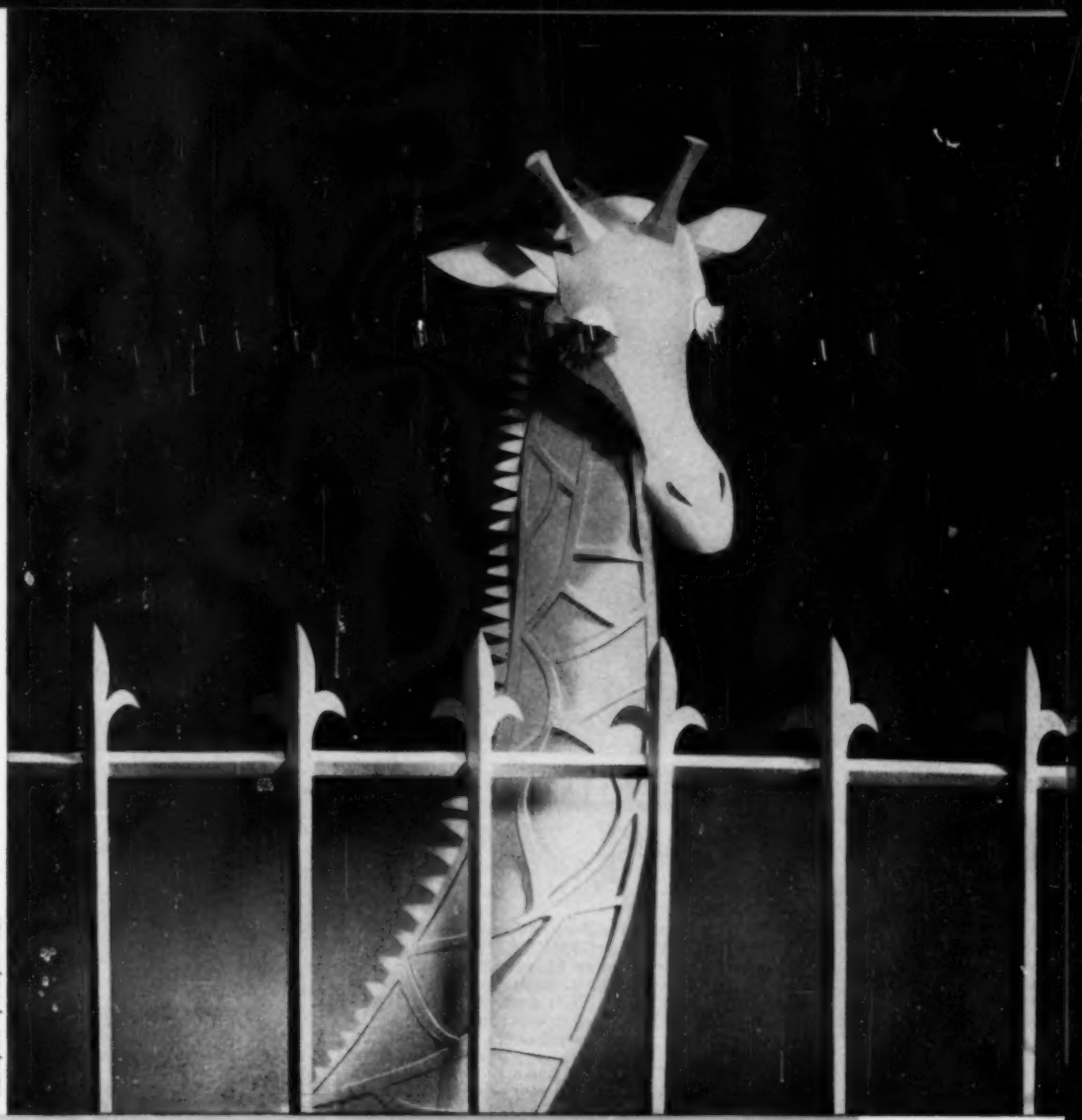
OFFICES: NEW YORK • CHICAGO • PITTSBURGH
WASHINGTON • CLEVELAND • SAN FRANCISCO




MIDVALE

*Custom Steel Makers to Industry*

PRODUCERS OF FORGINGS, ROLLS, RINGS, CORROSION AND HEAT RESISTING CASTINGS



paper sculpture by gerda-ogan

# LONG ON EXPERIENCE

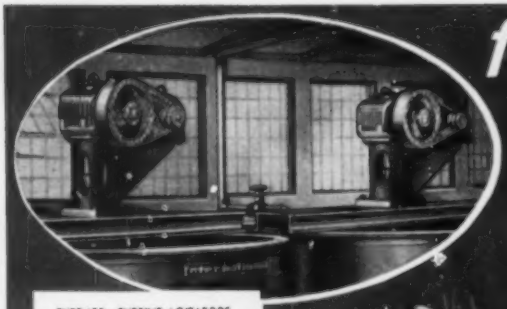
for over fifty years, NIAGARA has been producing top quality electro-chemicals... pioneering in the commercial production and application of a group of them.

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| NIALK® | Liquid Chlorine |
| NIALK | Caustic Potash |
| NIALK | Carbonate of Potash |
| NIALK | Paradichlorobenzene |
| NIALK | Caustic Soda |
| NIALK | TRICHLORethylene |
| NIAGATHAL® | (Tetrachloro Phthalic Anhydride) |

NIAGARA ALKALI COMPANY

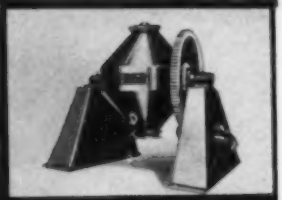
60 East 42nd Street, New York 17, N. Y.

# for Greater Savings in Production Costs

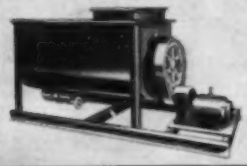


TYPE LRB—TURBINE AGITATORS with V-Belt Drive. Changeable Speed. Available for Open or Closed Pressure Tanks. Any Size.





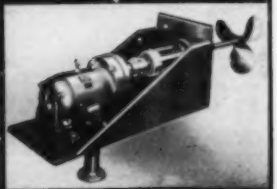
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From 25 to 10,000 lbs.



RIBBON MIXERS
From ¼ to 175 cu. ft.



BALL MILLS
Welded Steel Construction



SIDE ENTERING MIXERS
½ to 30 H.P.



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*Complete Processing Systems*

**To the Chemical and allied Industries, INTERNATIONAL ENGINEERING offers the most complete line of Modern PROCESSING EQUIPMENT ever presented—with a completely INTEGRATED and perfectly BALANCED SYSTEM of operation, for the highest efficiency and lowest costs.**

When you're making improvements, building a new plant, or expanding your present facilities, be sure to check with INTERNATIONAL for the latest Engineering Developments in improved EQUIPMENT for the correct and most economical BLENDING, TREATING, MIXING and GRINDING of Chemical components.

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*Memo from the Editor* **John R. Callaham**

# Your Mid-Summer's Reading

**Summer is looked upon as the season of light and languid reading. We can't promise you that, but we can promise you a spate of articles we think you shouldn't miss:**

- **A special issue: "Builders of the Chemical Century."**
- **A feature report on petrochemical processes.**
- **Another special report on size reduction.**
- **A new series of articles on equipment costs.**
- **A bagful of short-cuts on heat exchanger design.**
- **An unusual article on maintenance techniques.**
- **A unique chart on how to estimate process labor costs.**

And that isn't all, of course. For each of our issues will have close to 130 pages of articles, departments and news on processes, products, technology and equipment.

We've got one article scheduled—just to take an example—that'll give a materials balance equation by which you can gage the performance of your physical separation processes with any degree of precision. It'll work with distillation, adsorption, absorption, extraction, evaporation, size separation.

▶ **Chemical Builders**—Next month's issue will celebrate our 50th anniversary and at the same time pay tribute to what we call "those great builders of the chemical century." You'll enjoy, I think, the personal reminiscences that'll give you a glimpse of "the man" behind each of these great builders.

Then, too, one of our prizes in July will be the "what's ahead" section. Here we've pulled together the personal opinions and forecasts of close to 125 authorities in every major segment of the chemical process industries. You'll be surprised at some of the frank opinions and bold forecasts of these chemical leaders.

And Ray Ewell, well known chemical economist at Stanford Research Institute, will stick his neck out and tell you where he thinks the chemical process industries will be by 1975—in some instances by 2000! Dr. Ewell's industry trend curves are fast becoming classics among chemical economists.

▶ **Petrochemical Processes**—You've probably seen articles and reports on the petrochemical industry and its developments until you're well nigh fed up with them.

So when we signed up the author for our coming report on petrochemicals we make one stipulation: "We don't want another who's-putting-up-another-whopping-plant or oh-how-big-the-industry-is sort of thing."

Our report—and we believe it'll be the first published study to take this approach—will deal primarily with those processes and operations basic to the petrochemical industry. It will emphasize technology rather than statistics, processes rather than plants.

▶ **Size Reduction**—Within a very few months we'll be able to give you another of those comprehensive down-to-earth equipment reviews; this one will cover the whole field of size reduction in chemical process operations.

Here are some of the questions this report will answer: What are the basic types of equipment used for size reduction? What are the intrinsic features and advantages of each? What are their major applications and limitations in the chemical processing field?

I think you'll find this report something you can use now, certainly something you'll want to save for frequent use as a practical and permanent reference.

▶ **Equipment Costs**—Nothing seems to be in greater demand by chemical engineers than up-to-date information on process equipment costs. The big reason, I guess, is that it's so tough to get. Relatively little dollars-and-cents information has been published on the comparative costs of process equipment.

Now we're ready to start a brand new series of individual articles that'll give up-to-date costs on specific types of equipment. Each article will deal with a particular class of equipment: fans and blowers, dust collectors, mixers and many more.

This new series, we believe, will become a worthwhile addition to the articles we've already published over the past few years on equipment costs and cost estimating. Those articles, now collected into a 128-page reprint, have always been popular.

▶ **Heat Exchanger Design**—We've just signed up for a couple of articles I believe will be in really big demand. They will be a series on the kinks and short-cuts to heat exchanger design which the author has collected over his many years of experience in design work at one of the country's largest chemical plants.

Short-cuts such as these, of course, are great time savers for anyone doing design work. They also come in handy to engineers in production, process or development work.

The articles will cover all common combinations of conditions: turbulent and viscous flow, cross- and parallel flow, phase- and no-phase change and others. Most of the short-cut methods have never been published before.

▶ **Maintenance Techniques**—What's the productive time for your plant's maintenance crew? If it's 60 percent you're average for the chemical industry. Want to know how one big chemical plant has jacked up its average from 54 percent to a whopping 74 percent?

Well, Asst. Maintenance Superintendent Stuart Whitehead will tell you exactly how Calco Chemical did just that—at the same time, of course, slashing maintenance costs.

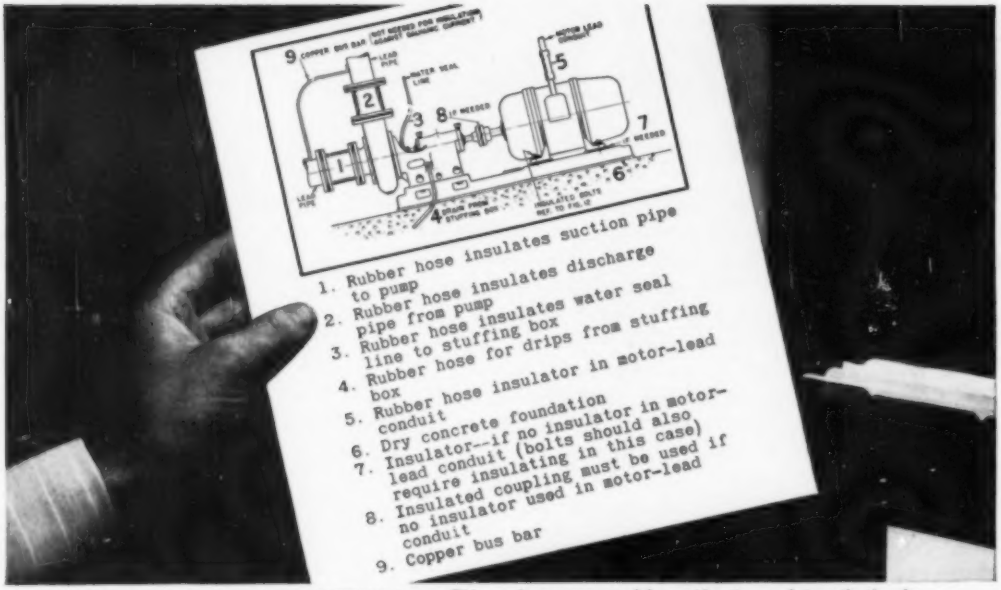
You'll be impressed by the top-notch job that Calco has done on streamlining its maintenance setup. It's based on many years of detailed analysis of the time-saving, cost-cutting advantages of decentralized area shops.

To our way of thinking, this article is one of the most unusual we've ever seen on chemical plant maintenance and how to organize it.

▶ **Process Labor Costs**—Sometimes an awful lot of helpful data can be condensed into a simple graph. That's the case with the unique chart we'll publish soon on how to estimate the man-hours of operating labor per ton of product for any size plant.

Beauty of this chart—which hinges on the new "unit step" concept—is that you can use it on any process, old or new, continuous, batch or mixed. And it works on any size plant from 2 to 1,500 tons per day.

(Continued on page 329)




ANOTHER CASE STUDY FROM THE WORTHINGTON FILES. This data sheet from the Worthington files indicates points at which an alloy pump should be insulated in order to eliminate stray-electric-current corrosion in an electrolyte circulating system. The solution to this problem was arrived at from very careful consideration and investigation by Worthington engineers working in conjunction with the pump user. The resulting installation—made some eleven years ago—was one of the first in the world where alloy (Worthite) pumps were used to circulate an electrolyte.

# Another Pumping Problem That Called For More Than a Pump!

***A check of the Worthington files would uncover many stories like this one. They're the best evidence we have of the "extras" you get with every Worthite* pump.***

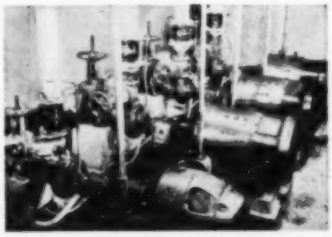
About eleven years ago Worthington specialists solved this problem of protecting pumps from stray current corrosion. As a result, Worthite pumps were installed in the manner illustrated above in the data sheet.

Today, after examination, there is practically no corrosion on the pumps. A life of 20 to 30 years is indicated for these Worthite pumps. Maintenance costs are a fraction of what they had been before. And the Worthite units required only 40 hp as compared to 75 hp for previously used (lead) pumps. They still deliver more electrolyte and have not fallen off in capacity after eleven years service.

During the same eleven years, copper and zinc refineries everywhere in the world have been specifying Worthite pumps for electrolyte circulation. Old refineries now modernize with them. Once again, Worthington's 111-year experience with pumping equipment helped to solve a tough problem for industry.

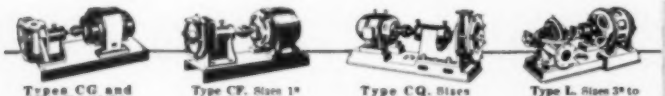
At Worthington, we'd like to hear about your pumping problems. Write Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.

*Reg. U. S. Pat. Off.



THIS ALLOY PUMP INSTALLATION FOR ELECTROLYTE CIRCULATION is comprised of these Worthite centrifugal pumps, 6-in. discharge by 8-in. suction. They circulate copper sulfate electrolyte and have been in service for eleven years without any indication of stray-electric-current corrosion. Note how pumps are insulated.

C-2.1



**Type CG and CGL.** Sizes ¾" to 10". Capacities to 8000 GPM; heads to 200 ft. Liquid ends of WORTHITE.

**Type CF.** Sizes 1" to 4". Capacities to 1000 GPM; heads to 130 ft. Standard, all iron and all bronze.

**Type CQ.** Sizes 1¼" to 3". Capacities to 600 GPM; heads to 130 ft. at 1750 RPM. Closed impeller.

**Type L.** Sizes 3" to 8". Capacities to 2250 GPM; heads to 300 ft. Single stage volute. For general service.

**The World's Broadest Line Assures You the Right Pump for Every Job**

**WORTHINGTON**

Centrifugal Pumps

*How do you know which*

# Positive Displacement Pump

*is right for your job?*

If you've ever suffered the consequences of a wrong choice in pumps, or if you're now making a choice and have some doubts, here's help.

GET THE ADVICE OF A PUMPING SPECIALIST—a manufacturer who makes *all* types of pumps—including all types of positive displacement pumps—and is in a position to treat your problem objectively without the desire to sell you one type over others.

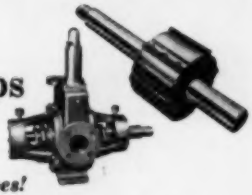
Worthington — oldest and largest pump manufacturer in the world — is equipped to do exactly this for you. With the most complete pump line to choose from, we can always find the one that fits your particular service conditions.

Write and tell us about your pumping problems. Be sure to give all pertinent details! Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Reciprocating Pump Division, Harrison, New Jersey.

## The Worthington Positive Displacement Pump Line includes all these . . .



### 1. Rotary Pumps

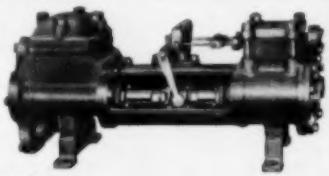


*Both gear and vane types!*

FOR VISCOUS LIQUIDS—SMOOTH, QUIET OPERATION. *Worthington Herringbone-Gear Pumps*, Types GA and GR; capacities from 1 to 5,000 gpm; pressures to 500 psi.

FOR NON-LUBRICATING, SLIGHTLY ABRASIVE OR CORROSIVE LIQUIDS. *Worthington Sliding-Vane Pumps*, Types VE and VR; external or internal bearings; capacities from 25 to 1,000 gpm; pressures to 200 psi.

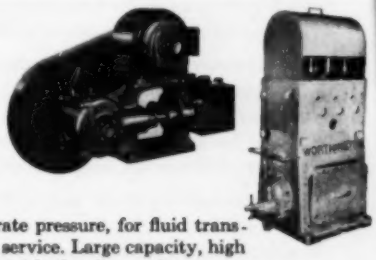
### 2. Steam Pumps



*If you use steam, why not drive pumps with it?*

Steam ends up to 250 psi maximum working pressure, hydrostatically tested to 375 psi. Hot-oil or cold-oil fitted. Simplex and duplex. All types: large and small; low pressure, high pressure; for general, boiler feed, refinery, steam heating and evaporator service.

### 3. Power Pumps



*Up to 2,000 hp!*

Small capacity, moderate pressure, for fluid transfer, refinery or general service. Large capacity, high pressure, for pipeline and hydraulic service.

P-2-7



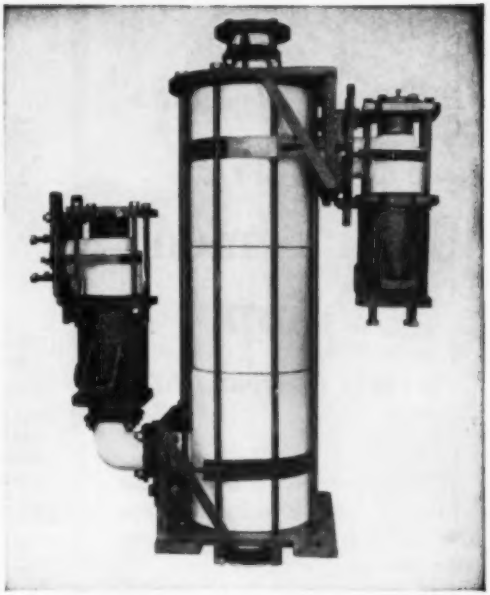

The World's Broadest Line Assures You the Right Pump for Every Job

**WORTHINGTON**

Reciprocating and Rotary Pumps



Worthington two-stage non-condensing ejector—porcelain



Worthington two-stage condensing unit—porcelain

# How To Maintain an Uninterrupted Vacuum

## in the presence of corrosive vapors

Use a Worthington corrosion-proof steam-jet ejector. These are made in stock sizes and specially engineered for handling any corrosive vapor problem in the chemical field.

For corrosive vapors, these ejectors are made with impervious graphite nozzles and diffusers. Suction chambers are of porcelain, but these can also be furnished of impervious graphite. Porcelain diffusers are also available.

For corrosion-*resistant* usage, Worthington makes ejectors of bronze, stainless steel or Worthite (a special Worthington "super-stainless").

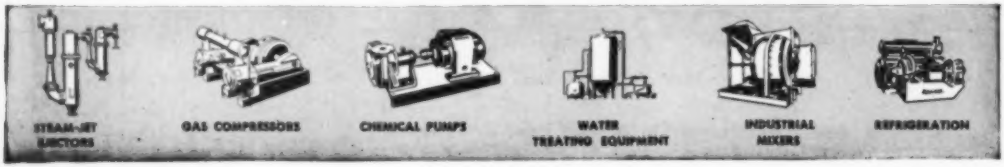
Worthington's is the *most complete* ejector line. A model for every vacuum requirement —from atmospheric to 50 microns absolute. Single and multiple stages. Condensing and non-condensing.

Put your problem—distillation, drying or any other vacuum problem—up to Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Steam Power Division, Ejector Section, Harrison, New Jersey.

**WORTHINGTON**

**STEAM POWER DIVISION**

X.1.2



# Powell makes a Complete line of valves TO HANDLE CORROSIVE FLUIDS

Until somewhat over a quarter century ago, valves made of bronze, iron, or steel could satisfy every existing industrial flow control requirement. But then the amazing development of the Chemicals and Process Industries began and the demand arose for valves of many other materials to resist an ever-increasing variety of corrosive fluids. Powell met the challenge promptly and ever since has been the leader in the field of corrosion-resisting valves.

**The Wm. Powell Co., Cincinnati 22, Ohio**

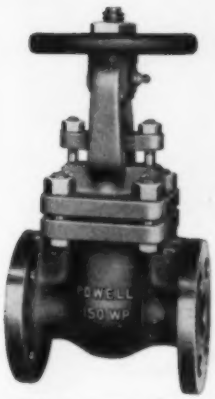



**Fig. 2481**—150-pound O. S. & Y. Gate Valve with precision-fitted, quickly interchangeable, solid or split wedge. Stem is threaded and guided through revolving bushing in upper yoke, which has a compression lubricant fitting. Available in a wide variety of corrosion resisting metals and alloys. Also made with screwed ends.



**Fig. 1861**—200-pound Stainless Steel Globe Valve with screwed ends, union bonnet, inside screw stem, plug type disc. Available in a variety of other corrosion-resisting metals and alloys

**Bell-O-Seal "Y" Valve.** Designed for high vacuum service and for handling hazardous, lethal, or malodorous fluids. Flexible metal bellows, enclosed in the body, completely seals interior of valve from outside atmosphere. Streamline design provides full flow area through valve. Made with flanged, screwed, or welding ends in various corrosion-resisting metals and alloys. Globe and Angle valves also available.






**Fig. 1944**—Large 150-pound "Y" Valve with bolted flanged yoke-bonnet and outside screw stem. Available in a variety of corrosion-resisting metals and alloys.




**Fig. 1561 S. S.**—Large size 150-pound Stainless Steel flanged end Swing Check Valve. Body-cap nuts and bolts are in Stainless Steel. These valves conform to latest standards. Available in various other corrosion-resisting metals and alloys.

**Powell Corrosion-Resisting Valves are made in these Metals and Alloys**

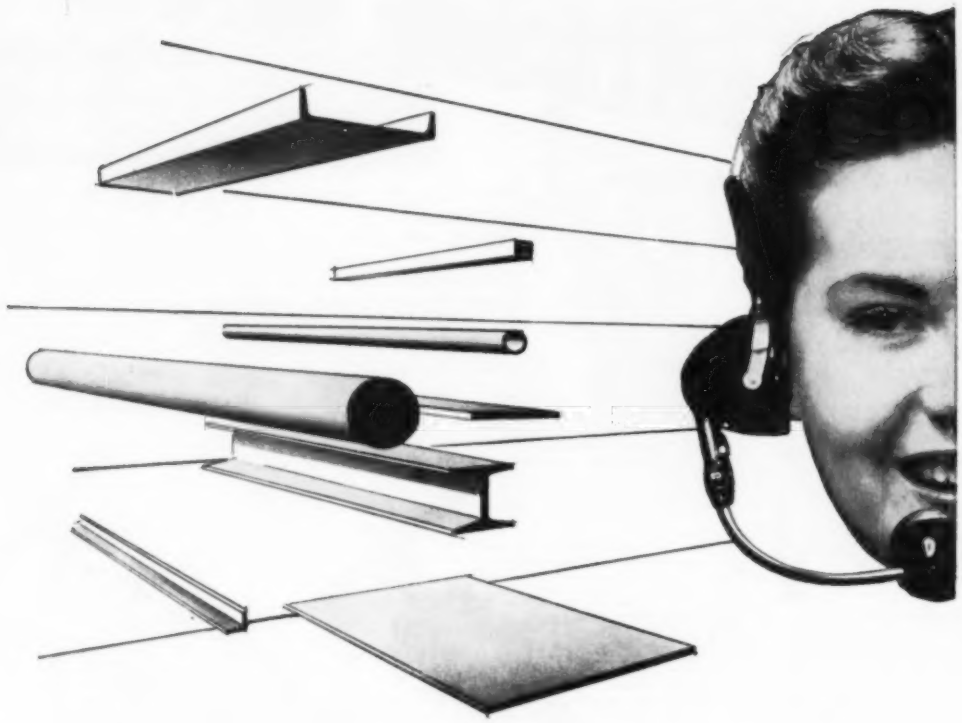
| Stainless Alloys | Cast Irons | Nickel and Nickel Alloys | Bronzes—Acid, Aluminum, Silicon | Alloy Steels |
|---|---|---|---|---|
| 18-8S | Cast Iron | Nickel | Everdur | Carbon Steel |
| 18-8S Mo. | 3% Nickel Iron | Herculoy | Herculoy | 4-6% Cr. 5% Mo. |
| 18 8S Cb. | Ni-resist* | Monel Metal* | Monel Metal* | 3.5% Nickel Steel |
| Misco "C" | | Inconel* | Ampco†† | 6-8% Cr. .5-.75% Mo. |
| Dunmet 20 | **Aluminum** | Hastelloy Alloys† | Ampcoloy†† | 8-10%Cr. 1.1-1.5%Mo. |
| 11.5-13.5% Cr. Iron | Alcoa No. 43 | (A, B, C and D) | 76 | |
| 18% Cr. Iron | Alcoa No. B-214 | Illium | 90-10 | **Silver Hard Lead** |
| 28% Cr. Iron | Alcoa No. 61 S-T | D-10 | 88-10-2 | |
| 25% Cr. 12% Ni. | | | | **Molybdenum** |

*Registered trade-names of the International Nickel Co., Inc.

†Registered trade-name of the Haynes-Stellite Co. ††Registered trade names of Ampco Metal, Inc.

# POWELL VALVES

**In Bronze, Iron, Steel and Corrosion-Resisting Metals and Alloys.**



# STEEL
# in Stock—Quick Shipment

Contact us for all your steel requirements and extend Government Allotments where they apply. Despite some shortages we can usually take care of most of your requirements. And prompt, personal service is always assured.

**PRINCIPAL PRODUCTS**

**CARBON STEEL BARS**—Hot rolled and cold finished
**STRUCTURALS**—Channels, angles, beams, etc.
**PLATES**—Many types including Inland 4-Way Safety Plate
**SHEETS**—Hot and cold rolled, many types and coatings
**TUBING**—Seamless and welded, mechanical and boiler tubes
**ALLOYS**—Hot rolled, cold finished, heat treated. Also tool steel
**STAINLESS**—Allegheny bars, plates, sheets, tubes, etc.
**BABBITT**—Five grades, also Ryertex plastic bearings
**MACHINERY & TOOLS**—For metal fabrication

# *Call* RYERSON

*SIDNEY D. KIRKPATRICK, Editorial Director* *JOHN R. CALLAHAM, Editor*

# Chemical Engineering

*WITH CHEMICAL & METALLURGICAL ENGINEERING*

*JUNE 1952*

## What Future for Rubber?

Government policy on synthetic rubber has been changed and is now being put into effect. These changes naturally bring up the question of the future of the entire synthetic rubber industry.

There will be no steps taken this year toward disposal of any government-owned plants for making any type of synthetic rubber. But this problem will most likely be brought up next year, particularly for special rubbers such as butyl. It is highly unlikely, though, that any action will be taken to dispose of GR-S plants even a year from now. A pro-industry president and a Republican Congress would seem to be the only hope that private industry will get a chance to own the rubber plants it now operates under government ownership.

All present plans are aimed at keeping skilled personnel, supplies of essential raw materials and functioning of all industry segments at a level that could supply GR-S at any rate (up to total capacity) faster than military and civilian demands could possibly develop.

Apparently government executives are convinced that butyl rubber will hold its position of dominance for many uses—especially inner tubes— without any assistance.

Yet there is some concern that government ownership and control have dulled the industry's incentive for aggressive research and development that would catalyze butyl rubber's technology and industrial growth. This concern may lead next year to legislation to sell the butyl plants and get the government out of the business of making this specialty rubber. Many people are convinced that such a move now would be in the public interest, yet the President and many influential legislators would undoubtedly oppose it during the present term of Congress. Official attitude next year may well be more favorable to private enterprise.

Some rubber companies now argue that they could design and operate new GR-S plants and turn out a product at lower cost than the present government-owned units. This, however, seems to be a moot point. Raw material costs now make up such a large part of manufacturing costs that improved technology would probably not lower the cost of the rubber by any large extent. Besides, the cost of new facilities and the necessity for higher rates of return on private capital might more than offset the advantages of improved technology.

Some authorities in Washington believe that the public interest can be served best through private industry only under one condition: Let the government sell its present plants "as is" at a low cost to companies that will agree to their maintenance and operation under terms that would protect the public against shortages and the government against scarcity in a military emergency. Yet experienced political observers realize quickly how difficult it might be for the government to sell these plants at their present depreciated value without charges of gross favoritism to those chosen as purchasers.

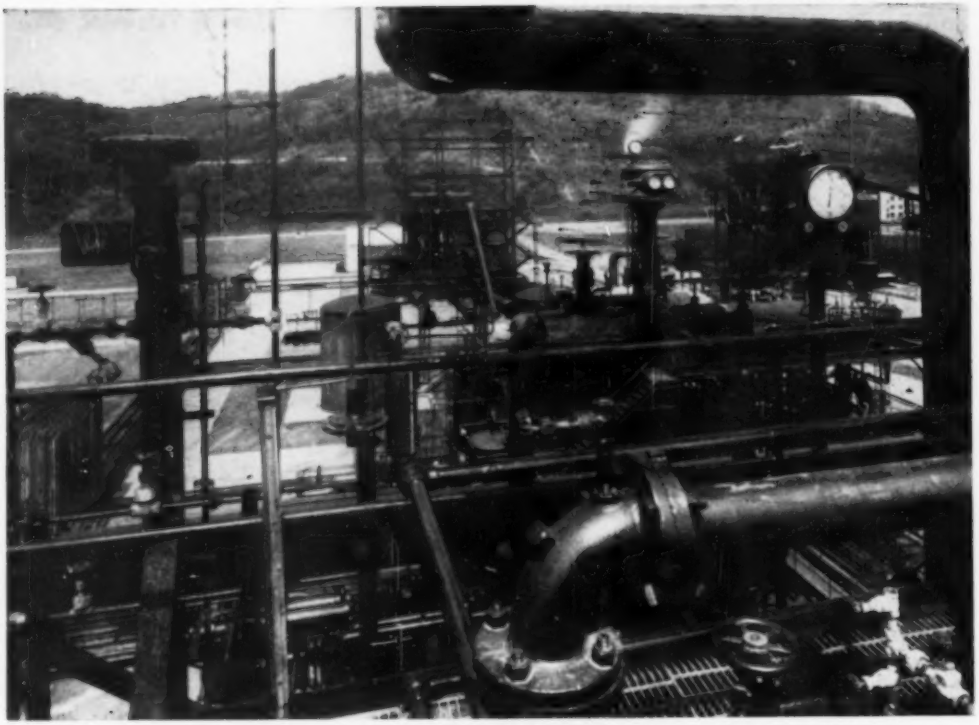
Actual economic difficulties may well be almost as great as the obvious political complications. Some observers do not see how the government will ever extricate itself from the manufacture of synthetic rubber until the present plants become so nearly obsolete that new facilities must be built.

At that time the question might very well be brought up: Would it be desirable—or necessary—to subsidize new private ventures in order to guarantee a synthetic rubber industry capable of satisfying the nation's needs? Private industry, of course, shys away from this suggestion.

Few people will deny the fact that the lack of private incentive makes most companies reluctant to embark on aggressive research and development programs to develop the technology and industrial uses of synthetic rubber.

In spite of all the political and economic complexities, we are convinced that eventually America's synthetic rubber industry should—and must—come under the stimulus of private, competitive enterprise.

John R. Callaham



NEW PROCESS is used in this $11 million pilot plant at Institute, W. Va. It now hydrogenates 300 tons of coal daily.

# Coal Hydrogenation Process . . .

## Carbide's pilot plant, now on stream for close to three months, is forerunner of giant units

JOHN R. CALLAHAM

Carbide & Carbon Chemicals Co. has now placed on stream what's believed to be the world's first high-pressure coal hydrogenation unit designed to produce chemicals as the primary products.

The unit—an engineering demonstration plant at Institute, W. Va.—cost $11 million and 4.5 years to design and build. It culminates some 17 years of research work that cost Carbide some $8 million. Close to another $2 million will be poured into the project this year.

Carbide's pilot plant, now on stream for close to three months, treats 300 tons of coal daily—a daring 300-fold scale-up of laboratory work. But that isn't all: Carbide engineers plan to hike this rate to 550 tons daily. Only 50 men operate the entire plant.

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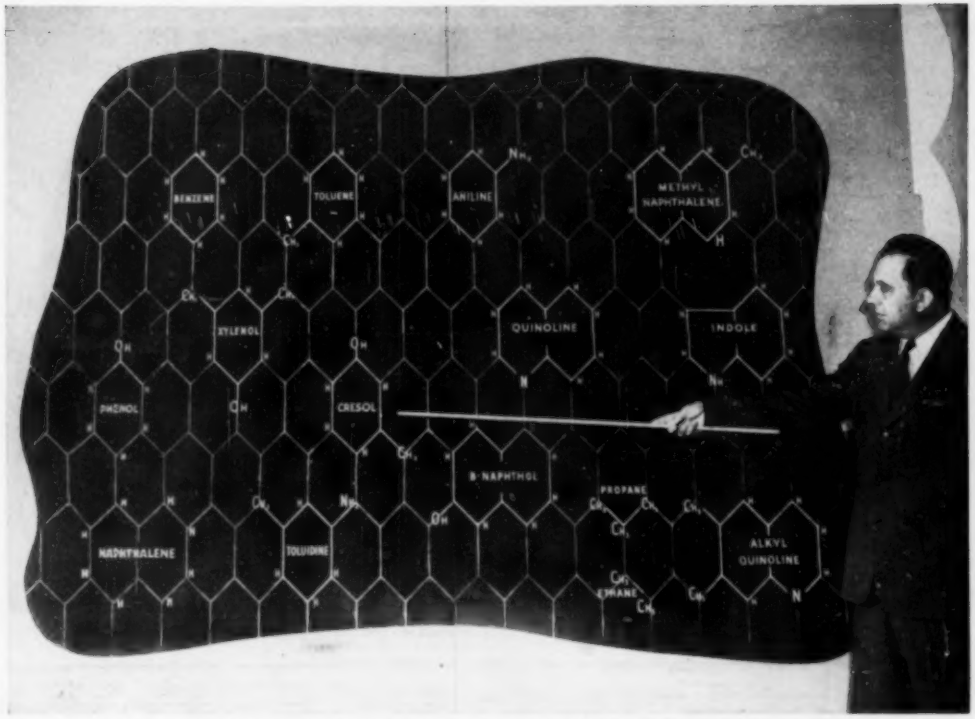
*Editor John Callaham paid a visit to Carbide's Institute plant last month, wrote this article from what he saw and heard.*

Purpose of the unit is (1) to yield last-word design and operating data for a commercial unit; (2) to show how much of which chemicals can be economically recovered under various operating conditions; (3) to test out different types of coal; (4) to get more data on catalysts; (5) to recover enough products to start a brass-tack cultivation of markets.

In addition, Carbide people say that the unit breaks even when operated at 300 tons daily, will show a healthy profit at a 550 ton rate!

It's obvious that Carbide's engineers have already learned plenty from their Institute experience. For one thing, they could slash 20 percent or more from the investment on a new plant.

Here's how we're placing our bets: (1) Carbide will probably build, maybe within the next five years, a hydrogenation unit to treat at least 3,000 tons of coal a day; (2) such a unit would cost, in 1952 dollars, less than $45 million.




NEW FIELD will include a vast number of aromatic chemicals, some of which Project Manager P. L. Alspaugh points out here.

# . . . Unlocks Vast Aromatics Field

**that'll open up new chemical fields to Carbide and the industry.**

Carbide's management people are deadly serious when they tell you they put great store in what this coal hydrogenation process will mean to them.

It means, to their way of thinking, that the company is opening up and can soon exploit a vast, new field of aromatic chemicals that in size and value might some day even challenge the aliphatic empire that Carbide has built up over the 32 years of its existence. Already, over 100 chemicals have been identified in the primary product from the Institute pilot plant.

With such possibilities in mind, it's easy to see why Carbide is putting all its coal hydrogenation eggs into the chemicals basket. The company isn't interested in liquid fuels; these are essentially degradation products that also call for higher investment, operating costs and raw material needs.

So Carbide has geared its process—unlike all others—to turn out the maximum of those higher aromatic chemicals that can command a premium price.

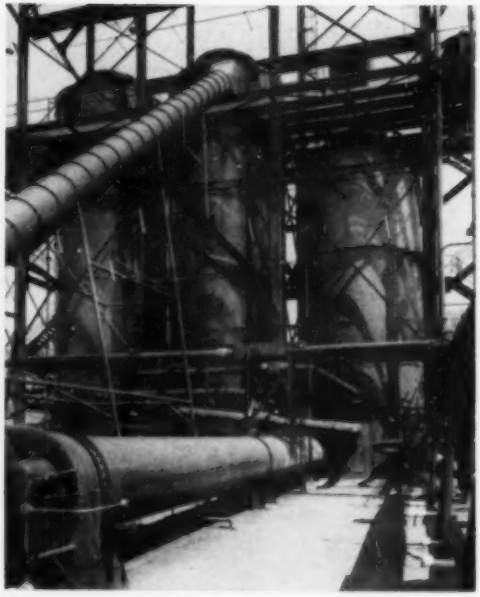
There is, however, one trick to the new process that might eventually pan out to be an aliphatic ace-in-the-hole: operating conditions can be varied so that large volumes of methane-to-butane gases are made. These are the raw materials for most aliphatics. It isn't economical under the present day supply and cost of natural gas, but Carbide could—and some day probably will—bank on coal as a basic source of any chemical, aliphatic or aromatic.

Significantly, Carbide is also tackling what normally would be hydrogenation's most expensive raw material: hydrogen. Company researchers expect to come up soon with what they think will be the first feasible process to turn out really cheap, tonnage hydrogen.

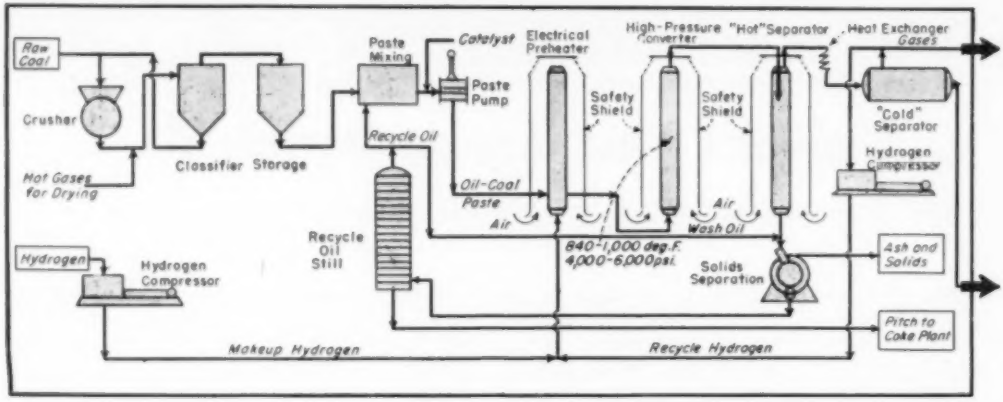
But for the chemical industry, the hydrogenation of coal to chemicals means one thing: the aromatics field—long tied to byproduct coking and secondary petroleum operations—will at last be free to surge ahead and cut out its own future.



COAL is prepared here by grinding, drying, mixing with oil.



COAL-OIL paste is hydrogenated in center pressure reactor.




## Institute's streamlined process for hydrogenating coal to aromatic chemicals bears the

Carbide's people are pretty sure they have a coal hydrogenation process that's several jumps ahead of anything else in the field. They're probably right.

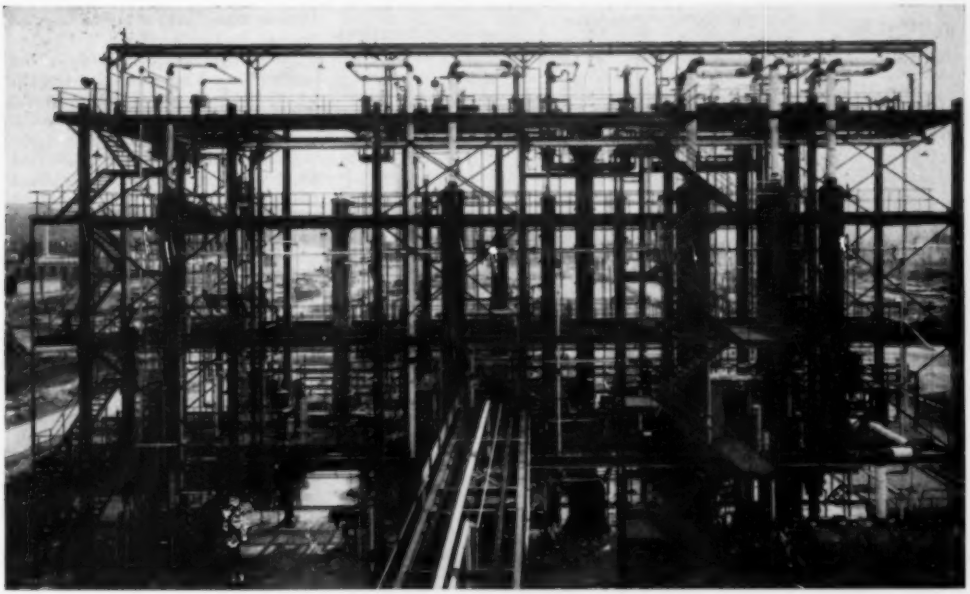
If you think they've come up with some brand new approach, it isn't so. There's little in Carbide's process that's basically different from other ways of hydrogenating coal to get chemicals or liquid fuels.

The basic steps are all pretty much the same: grind up coal, make a paste of it with oil, contact this paste with hydrogen at high pressure and temperature, separate out the complex chemical fractions that are formed.

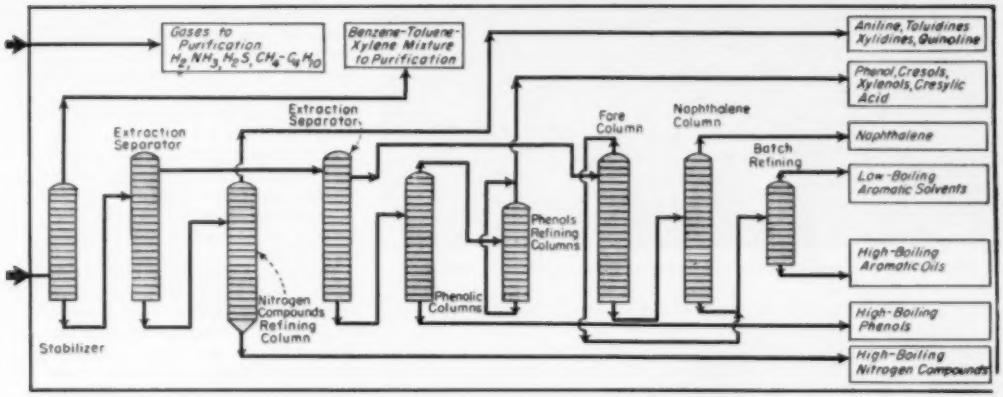
But what Carbide's technical people have done—and this is why their development has the earmarks of somthing big—is to make changes all along the line (". . . we've changed just about everything except the hydrogen compressors").

A streamlining of the process here, an improvement in equipment design there, a smart shortcut, a tricky piece of engineering—add up enough of these bits of ingenuity and know-how and you'll come up with an engineering achievement of the first magnitude, a technological development head-and-shoulders above anything else in the field.

That's what Carbide is sure it has done. Sure enough to go ahead and take the plunge into the field of coal hydrogenation aromatics.



CHEMICAL fractions are separated and purified in these towers by distillation, fractionation and solvent extraction.




**mark of engineering savvy all along the line.**

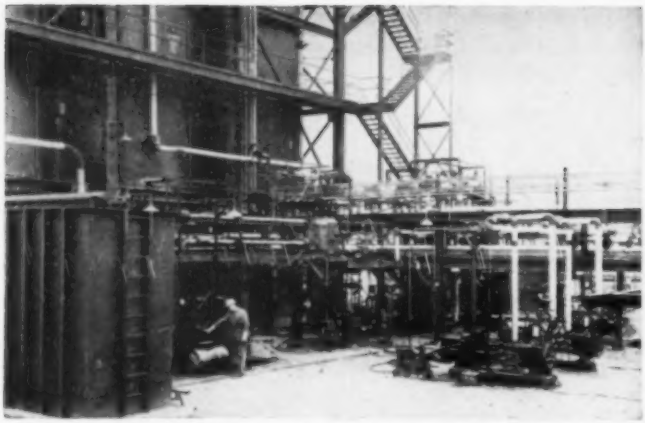
## One, Two, Three

Carbide's coal hydrogenation process can be boiled down to three distinct operations: (1) prepare the coal; (2) react it with hydrogen; (3) separate out the products that are formed. Here's a bird's-eye view of what happens at the Institute pilot or demonstration plant (see flowsheets):

Coal is crushed, ground, dried and then mixed with oil to make a paste. Actually, the coal pretty much dissolves to form a solution of coal-in-oil. This paste is then pumped under high pressure to the hydrogenation area.

The coal-in-oil paste is preheated, then sent to the high-pressure converter to react with hydrogen at about 840-1,000 deg. F. and 4,000-6,000 psi. The reaction mixture goes to the "hot" separator to take out the recycle oil and unreacted solids. The distilled products then go to the "cold" separator; this removes the gases from the liquid stream. Hydrogen is recycled to the converter.

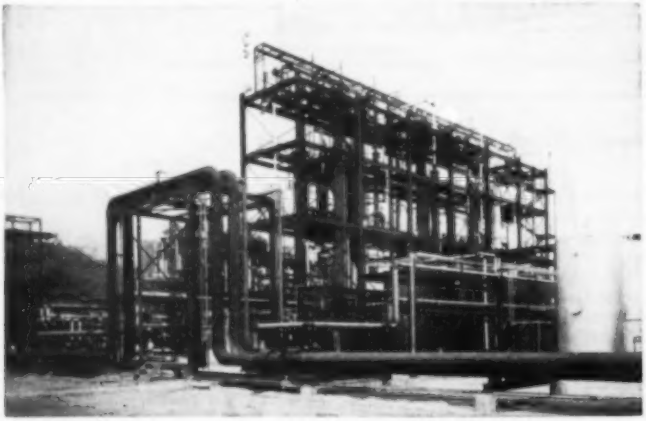
Actually, it is this liquid stream from the "cold" separator that's the "golden fleece" of the whole process. It is sent to the chemicals separation area—a maze of pipelines, stills and columns—where it is broken down into over a half-dozen chemical fractions or products. Most of these, in turn, can and probably later will be fractionated and refined into a host of aromatic end products.



HIGH PRESSURE vessels—center one is the hydrogenator—with auxiliary equipment.



HEAVY PRODUCTS separation area will provide fractions for chemical refining.



CHEMICALS separation unit with product receivers and storage tanks on right.

## Crush the Coal

Pittsburgh No. 8 coal from the nearby West Virginia hills is trucked to the plant. It is bulldozed to a pit, then carried on a belt conveyor to the primary crushing equipment.

Crushed coal goes up the second flight of the conveyor to a storage hopper that feeds a pulverizer; here it is reduced to about 20 mesh. Carbide engineers don't see why it's necessary to go any finer (Bureau of Mines has gone to 200 mesh) and pile up grinding costs since the 20-mesh particles dissolve readily in the oil anyway. This slash in grinding costs and equipment seems to be Carbide's engineering trick in this early stage of the operation.

The 20-mesh coal is dried at about 125 deg. C. in a continuous stream of hot gases from a producer burning natural gas or methane. The combustion is regulated so that the gases contain less than 1 percent $O_2$. Moisture-free coal does away with troublesome reactions that water might bring about in the hydrogenator.

## Make a Paste

Pulverized coal is then fed continuously into the oil-slurry or paste-mixing system. The paste is made up of 25-40 percent coal mixed with a highly aromatic oil recovered and recycled from the high-pressure converter.

The coal paste is pumped to the hydrogenation area by several steam-driven, double-action piston pumps at a pressure up to 6,000 psi. Temperature of the slurry here is about 150-250 deg.

Actually, the coal dissolves readily in the oil and is essentially dissolved even before it reaches the hydrogenation reactor. This is probably explained by the fact that bituminous coal is not carbon (as many people believe) but a macro-molecule hydrocarbon.

Ash (8-15 percent) and fusain carbon (8-15 percent) naturally don't go into solution. In high-velocity streams and especially at the paste pumps, these solids could cause a lot of serious erosion of equipment. Contrary to the experience of some others who have worked on coal hydrogenation, Carbide has had no trouble on this score—and doesn't expect any: ". . . one of our engineering tricks in equipment design and know-how."

It seems that another Carbide trick is in getting the coal to go into solution with the oil fast and almost completely. The nature of the re-

cycle oil has something to do with it.

Catalyst can be added at any of several points between paste mixing and the preheating of the oil-coal-hydrogen solution. The flowsheet shows it being added just before the oil-coal slurry goes to the paste pump.

Carbide apparently doesn't put much stock in catalysts. Any one of several types can be used, but it's doubtful if Carbide uses the conventional iron type. The amount of catalyst added also varies: 0.1-0.5 percent is the usual range at present. In contrast, most of the German-based processes require around 4-5 percent.

Since the amount of catalyst is so small and costs so little, Carbide engineers don't even bother to recover it. And they insist that they can operate the process just about as well without any catalyst, hint that it might very well be dispensed with altogether in a large commercial unit.

## Heart of the Process is the High-Pressure Reactor

The viscous solution of coal-in-oil is pumped at 4,000-6,000 psi. through an electrical preheater, where high-pressure hydrogen—recycle or make-up—is also fed into it. Since the hydrogenation reaction is exothermic, this preheater isn't particularly vital except for start-up periods. It can also be used to balance out heat content or to raise the operating temperature in the high-pressure converter to a higher level.

This preheater—like the converter and "hot" separator—is a steel, vertical pressure vessel surrounded by an 18-ft. diameter steel shield. Air enters at the bottom and surges upward between the shield and the pressure vessel itself. This is primarily a safety measure; the upward draft of air would immediately flush away any hydrogen that might escape from the vessels. Some coal hydrogenation plants use massive concrete walls instead.

Real heart of the entire process is the high-pressure, liquid-phase continuous converter where hydrogen reacts with the coal-oil solution.

And it's here that Carbide's people have probably contributed most to coal hydrogenation technology — both in equipment design and operating conditions. So it's easy to see why they don't talk much about it. As Vice President George Felbeck put it: ". . . I'm not exactly evading your questions, but that reactor and how we get it to work does represent a major result of the 17 years of research and over $18 million we've already sunk into coal hydrogenation."

The reactor itself is a forged steel vessel some 35 ft. high and 30 in. i.d. Its wall—7.5 in. thick—is made of a specially modified 6130 Cr-Mo-V steel with the chromium content raised to give greater resistance to hydrogen embrittlement. It also has a refractory lining.

Feed material—coal, oil, hydrogen —all flow up through the reactor. Operating temperature usually ranges from 840-1,000 deg. F., pressure from 4,000-6,000 psi., residence time from 3-4.5 min. The reaction is exothermic.

What the best operating conditions are, Carbide doesn't really know yet. That's one of the things it expects to find out from its Institute demonstration plant.

Chances are there will be a number of "best" conditions that'll be dictated by the types and relative proportions of products to be made. Thus process flexibility (the ability to shift emphasis from one group of products to another by changing operating conditions) will probably stand out as one of the key features of Carbide's process. From the economic angle, it's a bonanza.

## Feed Excess Hydrogen

Feed to the reactor can be looked upon as an actual solution of coal and excess hydrogen in oil. Under operating conditions in the vessel, practically all of the coal (except ash and fusain carbon, a total of 15-30 percent) can be hydrogenated and broken down into a vast number of aromatic chemicals. Actually this is not good economics, as hydrogen consumption gets too high if the pitch-like material is also hydrogenated into lighter products.

Hydrogen for the reaction now comes as a byproduct from Carbide's other operations at Institute and nearby Charleston. (And with plenty to spare, too, for these plants now pour forth enough byproduct hydrogen every day to supply a hydrogenation plant with a capacity of 1,000 tons of coal daily.)

In actual operations, close to 300-400 percent excess hydrogen is added to the coal-oil solution. This large excess keeps the hydrogen pressure high enough to keep down coking troubles in the reactor, also helps push the reaction forward.

The gas that doesn't enter into the reactions, of course, is compressed and recycled. Hydrogen makeup is about 25 percent of the total. The hydrogen is brought up to the reactor pressure by conventional, four-stage gas compressors.

## Cut Residence Time

One of the unusual things about the Carbide process is how the residence time in the reactor has been slashed—from about 45 min. in the German-based processes to less than 4.5 min. You don't have to do much figuring to see what that can do to throughput as well as to equipment and operating costs.

What's more, Carbide engineers will blandly tell you that they hope—and expect—to cut down that 4.5 min. another 50 percent! "Then," says Project Manager P. L. Alspaugh, "our problem might well be one of control rather than of reaction time."

In addition, Carbide evidently has done away with another big headache —coking-up in the reactor—that's plagued practically everybody in the field at one time or another. Institute has now been on continuous stream for close to three months, but there have been no signs of coking. Carbide's engineers don't expect any, either.

A lot of factors have contributed to this coke-free operation, but three stand out: (1) low residence time; (2) high hydrogen vapor pressure; (3) the absence of "dead" or void spaces in the reactor.

Engineering know-how also shows up in detail design features of the high-pressure equipment. Practically all high-pressure piping, for example, is welded—which isn't easy with many of the special alloys used. Only where it's absolutely necessary are flanges used. This, of course, goes a long way toward eliminating hazards and leaks as well as making it easy to go to higher pressures at any time.

One of the big engineering problems of the whole job, in fact, was the fabrication and welding of special-alloy equipment of such size. The plant now has the largest stainless steel forgings of their type ever made.

## Separate Hot and Cold

The reaction mixture leaves the top of the converter and goes into a similar high-pressure vessel called the "hot" separator. Here the liquid and vapor streams are separated, after which the pressure of the liquid stream is reduced.

Liquid product from the hot separator contains the extremely high-boiling oils, ash, fusain carbon and any unreacted coal. These latter—

as finely divided solids—are taken out of the oil by a solids separation process.

Several ways to do this are, or will be tried out: centrifuging, filtration, flash vaporization. The problem has always been a tough one in all coal hydrogenation processes. Carbide doesn't know yet which method will come out on top. These solids (normally about 15-30 percent of the coal feed) will probably find a market as a cheap filler material.

High-boiling oils from this liquid stream go to a recycle oil still. Here the pitch-like material is separated from the aromatic coal-dissolving oil; part of the oil is recycled to the paste mixing operation, the most volatile part is used as a wash to purge the remaining heavy oil in the solids separation step.

The pitch will probably be used to make high-quality graphite electrodes, hence could almost be looked upon as a premium product. The output of pitch is variable and hinges on operating economics. Less pitch, more hydrogen—that's the crux of the matter. But with no pitch, hydrogen consumption goes too high for sound economics.

Now back to the vapor stream from the "hot" separator, which passes through the coils of a water-spray heat exchanger and into the "cold" separator. In this small, horizontal vessel —essentially a still—the product stream is again split into gas-phase and liquid-phase streams.

Most of the gases (largely $H_2$ with some $NH_3$, $H_2S$ and $CH_4$-to-$C_4H_{10}$ hydrocarbons) at present are sent to a hydrogen compressor for recycle to the process. Some 75 percent of the hydrogen in Institute's present hydrogen cycle comes from these gases. But in a commercial plant they could be separated and purified or used as chemical raw materials. Even now, a portion of them are returned to Carbide's nearby plants for use as fuel or chemical processing.

Most interesting gases are the $CH_4$-$C_4H_{10}$ hydrocarbons. The quantity of these hinges pretty much on operating conditions: the more severe the conditions the greater the breakdown of the higher hydrocarbons and —if enough hydrogen is added—the greater the production of methane and light hydrocarbon gases.

So it seems to be the better part of economic wisdom, under normal conditions to suppress the output of these hydrogen-consuming degradation products.

## Separate the Chemical Fractions and Purify Them

But it's the liquid stream from the "cold" separator that really stirs up the enthusiasm of Carbide's management and sales staff. This is the chemical — the "pay-dirt" — stream. But it's a stream that requires a complete and complicated chemicals separation process (see *flowsheet*) to get those aromatic end products that are the excuse-for-being for Carbide's entire coal hydrogenation setup.

This stream contains all the important chemical products to be recovered: toluol, xylol, naphthalene, methyl naphthalenes and higher hydrocarbons; cresols, xylenols, phenol and higher monohydric phenols, aniline, toluidines, xylidines, quinoline, methylated quinolines, indole, and other higher-boiling nitrogen-containing chemicals.

This chemicals separation plant is conventional in that it uses the usual operations of distillation, fractionation and solvent extraction. It is complicated because of the variety, complexity and number of chemical products involved.

And actually, at least half of Carbide's $11 million investment at the Institute hydrogenation plant was sunk into this chemicals separation area. Although the bulk of the units are built of mild steel, the best material for many of the operations remains to be determined.

In the light products separation building the aromatic stream is first broken into three principal fractions by chemical reaction and solvent extraction: (1) a hydrocarbon portion; (2) a phenolic portion; (3) an aryl amine and nitrogen heterocyclic portion.

Hydrocarbons are separated by distillation into various products. One of these—naphthalene—is purified by crystallization.

The phenolic portion is separated by continuous distillation into two fractions; one contains the high-boiling phenols while the other is made up of phenol, cresols, xylenols and cresylic acid. Each portion, according to Carbide's present plans, will later be fractionated and refined into individual chemicals of commerce.

Crude hydrocarbon fractions can be refined into specification-grade aromatic solvents and other products. The nitrogen compounds portion is separated by batch distillation to yield aniline, toluidine, xylidines, quinolines and other products.

These are the chemical fractions that Carbide will later refine.

## What's for Sale?

You must remember that Carbide built its Institute chemical separation "demonstration" plant with one purpose in mind: to produce crude materials and to separate them so that later in a commercial plant well-known chemical processes could complete the refining job.

For this reason, few fully-refined salable end products will come out of the present Institute plant in the near future. However, here's the schedule as Vice President Harry B. McClure (who will be responsible for sales) sees it now:

First products for sale will be refined mixtures that include high-boiling phenols (mostly monohydric, alkyl substituted phenols) and aromatic-type hydrocarbon solvents (mostly alkyl substituted benzenes).

Small fractions of the amounts of certain aromatics that Union Carbide now buys as raw materials will come from the pilot plant: benzene, naphthalene, phenol, cresols, xylenols, aniline.

Commercial chemicals that'll probably be for sale soon after more study on their abundance and means of separation; toluene, xylenes, mixed toluidines, mixed xylidines, alkyl pyridines, indole, quinoline.

Other compounds have been identified in the coal hydrogenation fractions. Some of these may be offered for sale in the future if they prove to be present in economically recoverable quantities. Typical of this category: indane, acenaphthene, fluorene, anthracene, phenanthrene, indanol-4, indanol-5, 3-phenylphenol, quinaldine, carbazole, 2-methyl-6-ethylpyridine, 3-methylindole, dibenzofurane.

## Nobody's Worried

What will the markets be for these chemicals and how soon will they open up? "Those are questions we'll have to find the answers to," says Al Tenney, who heads up the market development program, "but we're not worried."

In fact, nobody in Carbide seems worried on that score even though some of the products have never before been produced in large commercial quantities.

And that attitude, in short, sums up the boldness of Carbide's thinking and the confidence its people have in their own research, engineering and sales talents.

Thus Carbide has taken the first, long step toward making an economic reality of coal hydrogenation as a prime source of aromatic chemicals.

## COAL HYDROGENATION COSTS

| According to... | Bureau | NPC | Ebasco |
|---|---|---|---|
| A coal hdrogenation plant costs | $414 million | $533 million | $404 million |
| Yearly operating costs are | 50 million | 75 million | 56 million |
| Daily input of coal (at $2.50 a ton) is | 14,000 tons | 12,960 tons | 14,800 tons |
| This gives daily crude oil yields of | 30,000 bbl. | 27,000 bbl. | 30,000 bbl. |
| And crude gives yearly yields of: | | | |
| 1. Motor fuel | 5.7 million bbl. | 6.4 million bbl. | 5.7 million bbl. |
| 2. Liquid petroleum gases | 2.2 million bbl. | 2.1 million bbl. | 2.2 million bbl. |
| 3. Benzene, toluene, xylene | 51.1 million gal. | — | 51.1 million gal. |
| 4. Miscellaneous chemicals | 126 million lb. | 133.6 million lb. | 125 million lb. |
| 5. Ammonium sulphate, sulphur | 148,000 tons | — | 148,000 tons |
| Sale of the chemicals would bring in | $44.2 million | $16.5 million | $40.3 million |
| And gasoline would have to sell at | 11¢ a gal. | 41¢ a gal. | 11¢ a gal. |
| To give investors a return of | 6.98 percent | 6 percent | 3.59 percent |

Figures are based on a plant to be located at Rock Springs, Wyo. Bureau and Ebasco figures are based on a 30,000 Bpd. (crude) plant, NPC rates the same plant at 27,000 Bpd.

# Coal Hydrogenation—More Cost Data

**• Whose cost figures are right? • Why another cost study anyway?**

**• Any future for fuels from coal?**

It's beginning to look like a bleak economic forecast is taking the fire out of the eyes of the proponents of synthetic liquid fuels from coal hydrogenation—at least so far as the private investor is concerned.

That's what the third cost study on the coal route to synthetic fuels adds up to. Ebasco Services, Inc., a New York firm of engineering and business consultants, recently issued a report of some 158 pages plus appendices on the subject.

Ebasco was retained by the Bureau of Mines after the National Petroleum Council had said, last fall, that the cost data on coal hydrogenation plants developed by the bureau were substantially in error. The bureau decided to counter with an independent cost study. This article is a condensation of the significant findings in the report.

The job assigned to Ebasco was "to evaluate certain elements of a report prepared by the Bureau of Mines entitled 'Cost for Coal Hydrogenation,' such evaluation having as its ultimate objective the determination of the selling price of gasoline and liquified petroleum gas produced by the coal-hydrogenation method."

The report goes on to say:

"As the determination of these prices is reserved to the Bureau of Mines, the ultimate objective will be served by this report only to the extent that the bureau may make use of the conclusions contained herein in its complete analysis of the subject. The immediate scope of the investigation is limited to those items of the cost estimate in connection with which a substantial difference exists between the report of the Bureau of Mines and the estimates and report commentary submitted by the National Petroleum Council."

## ASSUMPTIONS—Bureau specified controlling conditions.

To provide a common basis for comparison and to limit the scope of the study, the following controlling dates, production volumes and other conditions were specified by the bureau:

- Construction costs of labor and materials to be those prevailing Jan. 1, 1951.
- Comparison of operating cost totals to include cost figures for coal and chemical raw material as furnished by the Bureau of Mines. These cost figures were not to be reviewed by Ebasco.
- The cost of water for process make-up and for general plant use not to be reviewed.
- The analysis of gross revenue from sale of product to assume the plant in operation with a ready market for all fuel products in stated volumes of annual production at market prices that were prevailing at the time of Jan. 1, 1951.
- The financial analysis to be predicated upon conditions prevailing as of Jan. 1, 1951, with respect to interest rates and availability of money.

In order to take account of the variation in product yields from different types of coals, and of construction and operating conditions which might cause differences in both design and capital costs, two plant locations were selected for Ebasco by the Bureau and cost estimates prepared on both plants.

The first location, Rock Springs, Wyo., was selected as typical of a plant based upon the coals available in that general area and representative of regional conditions affecting construction cost and other factors such as transportation, housing, labor, water supply and market for product. Similarly, Union County in western Kentucky was selected as representative of coal supply, construction cost and operating conditions of the Illinois-Indiana-West Kentucky region. (The Kentucky and Wyoming sites were investigated in the two previous studies. The chart on the preceding page is based on the site of the Rock Springs, Wyo. plant.)

The general basis of the investigation is the so-called conventional plant using the German Bergius process.

Here's how the report breaks down the most essential costs:

## COST I—$51.4 million est. to construct the power plant.

The estimated construction cost for power plant, adjusted to the January 1951 level of prices for equipment and materials, and of labor rates, is approximately $51,400,000. This is derived from the estimate as prepared during January 1952, using prices and wage rates then in effect, and adjusting the total cost figure to reflect the over-all change of power plant construction costs during the previous twelve months—a rise of approximately 5 percent. The power plant, itself, is designed to carry continuously the hydrogenation plant load which is estimated at 270 mw gross generation, and to supply steam for consumption in processes aggregating 120,000 lb. per hr. at 370 psig. and 850,000 lb. at 45 psig. The fuel burned in the plant is coal and process coke. Both of these fuels can be furnished from activities within the hydrogenation plant.

This estimate is roughly $4 million lower than the Bureau of Mines estimate of $55,500,000 both as of January 1951. Here are the details of cost:

| **Power Plant Construction Cost** | |
|---|---|
| Structures and improvements | $7,400,000 |
| Boiler plant equipment | 20,750,000 |
| Turbine-generator units | 12,200,000 |
| Accessory electrical equipment | 3,600,000 |
| Miscellaneous power plant equipment | 300,000 |
| Indirect construction costs | 1,750,000 |
| Omissions and contingencies | 3,800,000 |
| **Specific construction cost** | $49,800,000 |
| Overhead construction accounts | |
| Engineering | 1,500,000 |
| Engineering and construction management fee | 1,700,000 |
| Total construction cost, excluding interest during construction, as of Jan. 1952 | $53,000,000 |
| Adjusted cost, as of Jan. 1951 | $51,400,000 |

## COST II—$56.1 million for plant to purify, compress $H_2$.

Estimated construction cost for the Rock Springs, Wyo., plant is $56,184,000 based on the January 1951 level of prices for equipment and material, and of labor rates. Corresponding construction cost for the West Kentucky facilities is $53,664,000, reflecting the difference in atmospheric pressure and process changes consistent with the different coal used and other factors relating to the West Kentucky location.

This section of the coal hydrogenation plant has the function of producing, purifying, and compressing hydrogen for the hydrogenation of coal to produce liquid hydrocarbon fuels and chemicals. Each of the two plants has a capacity for 30,000 bbl. of product per calendar day. Both plants use the same basic process and raw materials with the sizes and flows also being similar except for variations reflecting the differences in composition of the coal to be used in each location. The facilities for compression and purification of hydrogen are well-known and widely used in the manufacture of synthetic ammonia and no problems need be anticipated with this type of process other than determining the cost of construction of plants of the large capacity required. The process and equipment used in the hydrogen section combine the recovery of pure hydrogen from three different sources.

By way of comparison, the bureau estimates for construction of the hydrogen plants were $57,948,000 for the Rock Springs, Wyo., plant and $57,948,000 for the West Kentucky plant.

Here's the way Ebasco's costs are broken down:

| **Hydrogen Plant Construction Cost** | Wyoming | W. Kentucky |
|---|---|---|
| Production equipment fob origin | $15,761,000 | $15,014,000 |
| Piping and insulation | 10,975,000 | 10,536,000 |
| Electrical materials | 4,979,000 | 4,786,000 |
| Instrumentation and auxiliaries | 742,000 | 712,000 |
| Equipment foundations | 1,041,000 | 1,002,000 |
| Protective coatings and painting | 213,000 | 210,000 |
| Erection labor | 5,980,000 | 5,762,000 |
| Erection materials | 825,000 | 800,000 |
| Buildings, services and cranes | 2,436,000 | 2,419,000 |
| Chemical control facilities | 101,000 | 101,000 |
| Yard work and support structures | 353,000 | 353,000 |
| Freight—equipment and materials | 729,000 | 222,000 |
| **Indirect construction accounts** | | |
| Field office accounts | 265,000 | 280,000 |
| Equipment rental | 207,000 | 207,000 |
| Safety and welfare | 97,000 | 97,000 |
| Payroll overheads and insurance | 756,000 | 735,000 |
| Overhead construction accounts | | |
| Engineering | 3,958,000 | 3,955,000 |
| Engineering, construction management fee | 1,650,000 | 1,615,000 |
| | $51,077,000 | $48,786,000 |
| Contingency, 10 percent | 5,107,000 | 4,878,000 |
| Total construction cost exclusive of interest during construction—as of January 1951 | $56,184,000 | $53,664,000 |

## COST III—$55.7 million needed for each year's operation.

| Operating Costs | Wyoming: Number of Employees Bureau | Wyoming: Number of Employees Ebasco | Wyoming: Annual Cost x $1,000 Bureau | Wyoming: Annual Cost x $1,000 Ebasco | West Kentucky: Number of Employees Bureau | West Kentucky: Number of Employees Ebasco | West Kentucky: Annual Cost x $1,000 Bureau | West Kentucky: Annual Cost x $1,000 Ebasco |
|---|---|---|---|---|---|---|---|---|
| **Direct costs** | | | | | | | | |
| Raw material | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Coal, 14,800 tons/day x 330 x $2.50 | ..... | ..... | $12,200 | $12,200* | ..... | ..... | $12,120 | $12,120* |
| Catalyst, chemicals, $5,429 per day | ..... | ..... | 1,790 | 1,790* | ..... | ..... | 1,780 | 1,780* |
| TEL | ..... | ..... | 828 | 828* | ..... | ..... | 775 | 775* |
| **Direct labor** | | | | | | | | |
| Operating labor | 702 | 1,041 | 2,730 | 4,713 | 702 | 1,041 | 2,730 | 4,713 |
| Operating supervision | 70 | 119 | 410 | 645 | 70 | 119 | 410 | 639 |
| **Plant maintenance** | | | | | | | | |
| Labor | 1,029 | 1,170 | 4,116 | 4,974 | 1,029 | 1,170 | 4,116 | 4,968 |
| Material | ..... | ..... | 2,058 | 5,873 | ..... | ..... | 2,055 | 5,873 |
| Payroll overhead | ..... | ..... | 1,161 | 1,880 | ..... | ..... | 1,161 | 1,878 |
| Operating supplies | ..... | ..... | 1,235 | 712 | ..... | ..... | 1,235 | 697 |
| Total direct cost | ..... | ..... | $26,528 | $33,626* | ..... | ..... | $26,385 | $33,443* |
| **Indirect costs** | | | | | | | | |
| General administrative | 125 | 256 | 1,055 | 1,975 | 125 | 256 | 1,055 | 1,895 |
| Indirect operating cost | 350 | 331 | 4,220 | 2,048 | 350 | 331 | 4,220 | 2,027 |
| Total indirect cost | ..... | ..... | $5,275 | $4,026 | ..... | ..... | $5,275 | $3,922 |
| **Fixed costs** | | | | | | | | |
| Local, County, State taxes | ..... | ..... | 3,558 | 3,490 | ..... | ..... | 3,435 | 3,351 |
| Insurance, depreciation | ..... | ..... | 14,858 | 14,623 | ..... | ..... | 14,343 | 14,007 |
| Total fixed cost | ..... | ..... | $18,416 | $18,122 | ..... | ..... | $17,778 | $17,358 |
| Cost of operation without profit and interest | 2,276 | 2,917 | $50,219 | $55,773 | 2,276 | 2,917 | $49,438 | $54,723* |

* Estimates of raw material costs were excluded from scope of Ebasco assignment. Amounts shown are estimates made by Bureau of Mines.

## REVENUE—$76 million if average year's output were sold.

The yearly volume of products considered marketable by 1955, along with a comparison of Bureau estimates is as follows:

**Output, 30,000 Bpd. Plant:**

| | Wyoming: Ebasco Services | Wyoming: Bureau of Mines | West Kentucky: Ebasco Services | West Kentucky: Bureau of Mines |
|---|---|---|---|---|
| Benzene | 11,750,000 gal. | 11,750,000 gal. | 12,700,000 gal. | 12,700,000 gal. |
| Toluene, xylene | 39,350,000 gal. | 39,350,000 gal. | 42,390,000 gal. | 42,390,000 gal. |
| Phenol | 43,800,000 gal. | 43,800,000 lb. | 77,000,000 lb. | 77,000,000 lb. |
| m-p-Cresol | 50,000,000 lb. | 64,400,000 lb. | 80,000,000 lb. | 77,000,000 lb. |
| o-Cresol | 6,600,000 lb. | 6,600,000 lb. | 6,800,000 lb. | 6,800,000 lb. |
| Xylenol | 25,000,000 lb. | 25,000,000 lb. | 25,000,000 lb. | 25,000,000 lb. |
| Ammonium sulphate | 131,000 tons | 131,000 tons | 129,000 tons | 129,000 tons |
| Sulphur | 17,100 tons | 17,100 tons | 80,000 tons | 80,000 tons |
| Motor fuel | 286,260,000 gal. | 284,800,000 gal. | 255,210,000 gal. | 251,910,000 gal. |
| LPG | 108,800,000 gal. | 108,800,000 gal. | 126,800,000 gal. | 126,800,000 gal. |

**Revenue From These Products at Jan., 1951, prices is:**

| | Wyoming: Ebasco Services | Wyoming: Bureau of Mines | West Kentucky: Ebasco Services | West Kentucky: Bureau of Mines |
|---|---|---|---|---|
| Aromatic hydrocarbons, tar acids | $34,088,000 | $37,955,000 | $44,760,000 | $49,350,000 |
| Ammonium sulphate and sulphur | 6,254,100 | 6,254,000 | 7,485,000 | 7,485,000 |
| Motor fuel and LPG | 35,838,600 | 35,650,000 | 34,413,100 | 34,050,000 |
| Total product revenue | $76,180,700 | $79,859,000 | $86,658,100 | $90,885,000 |

## RETURN—On risk capital too small for private investors

Ebasco was also asked to evaluate the financial program presented in the Bureau's report and to recommend, if deemed necessary, alternate or substitute programs.

Here's what Ebasco said:

"Considering the stable character of the business, we believe that it may safely be capitalized with a fairly high percentage of debt. However, we feel that 60 percent debt, as proposed in the Bureau of Mines report, would be difficult to arrange under Jan. 1, 1951, conditions. A capitalization consisting of 50 percent debt and 50 percent equity would, in our opinion, be more realistic.

"We believe that the assumed interest rate of 3¼ percent on the debt is fair, under Jan. 1, 1951, conditions.

"Using the capital requirements as adjusted to reflect our revisions of estimated plant costs, the alternative capitalization ratios, and the estimates of operating revenues and costs as adjusted by us, we have computed the return on the equity investment for the average year of operations while the debt is outstanding. Including the ammonia and sulphur recovery, for the average year the estimated return on equity amounts to from 3.59 percent to 4.26 percent for Rock Springs, Wyo., and from 6.22 percent to 7.56 percent for West Kentucky, with the lower return in each case representing an assumed capitalization of 50 percent debt and 50 percent equity. These estimated rates of return may be compared with the rates of 6.98 percent for Rock Springs and 10.84 percent for West Kentucky shown in the Bureau of Mines report, in which 60 percent debt ratio was assumed.

"We believe that this range of indicated return on equity is so low that the private financing of the projects is impossible. Considering the character of the business, and in view of the fact that the equity investor in these projects would get no return at all during the construction period of 3 to 4 years, we think that, in order to attract equity investment, the indicated return would have to be from 14 to 16 percent. We have calculated the increases in net income before and after income taxes which would be necessary in order to produce such returns on the equity for the average year, and find that in the case of the Rock Springs, plant, the net before income tax would have to be increased by some $31,500,000 to $50,000,000, and in the West Kentucky case, the net before income tax would have to be increased by some $21,700,000 to $41,200,000.

"We do not believe it would be feasible to finance the projects described in the Bureau of Mines report dated Oct. 25, 1951 with private capital under conditions prevailing Jan. 1, 1951."

DOLLARS AND SENSE HELP FIGHT . . .

# Piracy and Job-Hopping



RICHARD V. REEVES

Tom Ripp walked into the office of his boss, an earnest look on his face.

"Bill," he began, "remember that trip I made to the West Coast a few weeks back?"

"You mean that pharmaceutical job in L. A.?"

"Yeah, that's the one. I talked quite a bit with the brass while I was out there. Guess they think I've got some savvy they can use. They've offered me a 30 percent boost in pay to come out and work for them."

"Gonna take it?"

"Don't think I can afford to pass it up, Bill. Three kids drink a lot of milk."

Bill didn't answer, just mumbled something like "a swell break, kid, with that California sunshine to boot." He knew that he had lost a good engineer and there wasn't a darned thing he could do about it. The company couldn't meet an offer like that—wouldn't be fair to the other fellows. Besides the Salary Stabilization Board would never approve it.

Tom Ripp's case wasn't unique. Employers of engineers throughout the country were losing men the same way—one or two engineers in some cases; an alarming 20 or 30 percent in others.

Some companies shrugged their shoulders and called it "normal turnover," others screamed "piracy" and they screamed until they were heard in Washington.

We first got wind of it when Joe Cooper, executive director of SSB, came to McGraw-Hill to confer with some of the engineering editors, to give and get some advice on what SSB has called a serious problem.

"How serious was this problem of pirating engineers in the chemical industry?"

Joe Cooper wasn't sure. The problem seemed to be centered in electronics and aviation.

"Would it do any good to throw some light on the situation among chemical engineers?"

Mr. Cooper was sure it would.

So we got to work. Teletypes went out to CE's editors in the Midwest, the Southwest and the Far West. "Interview all the personnel directors in sight. Find out if they've got a problem and if they have, what they're doing about it." Meanwhile, the New York office began checking on the situation in the East.

Here's a regional breakdown on the answers we got:

EAST

In general, chemical companies here have felt no pinch in their technical staffs resulting either from "inducement by competitive employers," or from what might be called "instability of employment"—job hopping. Managements who found that they were losing a greater-than-usual number of engineers quickly looked to the most logical cause, promptly petitioned SSB to bring salaries into line. One manager of technical employment commented "today it's axiomatic that if you're not up to the going rate, you'll lose your engineers faster than you can count them, to say nothing of recruiting new ones."

That going rate in the East is from $325-$355 per month for an engineer with a bachelor's and no experience with the lower figure quoted most often. A fellow with a master's can command from $365-410. A Ph.D. can get from $500 up.

Starting with these rates a company will allow about $25 or $30 a month above the base for each year of experience to a certain limit.

Although most eastern companies do not pay their engineers for overtime, very few make a habit of extending the work week. Some companies allow time off at the employee's convenience to compensate for overtime.

One company which is unionized (technical personnel) pays time and a half for anything over 40 hr. to any employee earning less than $121.11. Those above this figure draw $4.55 an hour "for all hours in a scheduled extended work week which are in excess of 40."

Typical of the comments from eastern chemical companies are the following:

"We have lost very few engineers. We feel that the changes that were made, in most cases, were by men who were not especially stable and find that by and large our engineering staff has remained unimpaired. Our salary scale is based on the Los Alamos curve, with a regular merit increase system which seems to be proving adequate for the needs of our technical personnel."

"Lifting of wage ceilings would not help, it would cause much more trouble."

"We have noticed that the very small concerns can hire one or two people and call them almost anything they like and so they are in a position to offer them more money than the standard classifications permit the larger companies to offer."

"We have no problem in keeping our engineers. We do have trouble, however, in trying to hire recent graduates with all of the high pressure recruiting that goes on."

These and similar comments echoed the sentiments of personnel managers in the eastern part of the country. Most felt that they had no more than a normal amount of turnover in their outfits, and so long as they were able to continue to keep their salaries up to what the competition was paying, they needn't worry.

Almost all had a word of caution, though, for the job-hopping engineer. The most persistent comment was something like, "Don't have a long list of *former* employers. The first thing a new employer looks for is stability. A man who changes jobs too often and without good reason is poison, shortage or no."

MIDWEST

None of the big companies in the Midwest seems to have suffered from actual pirating—nor have they engaged in the vile practice, they say.

Personnel directors in the Midwest complain that most of their trouble is with older men who can get premium wages almost anywhere. Some directors feel that wage stabilization will be felt more and more as time goes on and living costs go up.

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DICK REEVES, *assistant editor of* Chemical Engineering, *says that all the credit for the survey goes to CE's alert regional editors:* JIM LEE *in the Southwest,* FRANK BYRNES *in the Midwest,* ELLIOT SCHRIER *and* JENNESS KEENE *(McGraw-Hill News Bureau) on the West Coast.*

**ALERT COMPANIES ARE . . .**

**1. Boosting salaries up to the going rate—or higher.**

**2. Ironing out salary inequities among older employees.**

**3. Refusing to hire engineers with job-hopping records.**

**4. Trying to be more human, recognizing good work, frequently checking progress.**

**5. Keeping hiring practices—especially when hiring from competitors—honest, ethical, in the open.**

**SMART ENGINEERS ARE . . .**

**1. Not jumping at the bait of high salary but going after the job they want at the salary they're worth in the geographical area they prefer.**

**2. Looking closely at things like security, merit increases, pension plans and other benefits before changing jobs.**

**3. Making sure that they are utilized to the best of their ability.**

**4. Not selling short their present employer where he is fair and honest.**

As far as salaries go, the companies that were starting ChE's at $275 or $290 last year are glad to pay $325 this year for all they can get.

The average figures for a B.S. in the Midwest are: starts at about $316, in 6 months, gets $345, in 1 year, $375, in 18 months, $404, in 2 years, $433. A fellow with a master's degree starts anywhere from $355-$375, advances proportionately with the B.S. graduates. A Ph.D. begins from $500-$525.

Some of the more pertinent comments from the Midwest were:

"Assuming that we do have a problem in the chemical industry, I believe it is caused by the fact that many well-established companies were paying the same wages for engineers that they were paying for craftsmen—and with the industrial boom precipitated by the Korean war, they found that companies which were expanding were outbidding them for their engineers."

"The problems might be solved by lifting wage ceilings, but I honestly believe a majority of the chemical companies are paying all they can afford to pay at the present time."

SOUTHWEST

None of the companies in the Southwest voiced any difficulty from pirating. They are aware of the problem, however, and are keeping well abreast of competition as far as salaries go.

B.S. graduates start from $340-$345. As an example of increases during the first two years, one company has put through a plan to raise these engineers to $425 before the end of two years. Engineers with an M.S. start from $380-$385.

Most companies in the southwest do not pay their engineers for overtime unless a 6-day week is scheduled. Most companies are not unionized.

Some of the older engineers in the Southwest have done some grumbling and management seems to be aware that there is a very serious inequity created in some cases. Where there are evidences of these inequities companies are taking what they call the necessary steps to correct them.

WEST COAST

The West Coast, like the Southwest, is paying a little more to get its engineers. A B.S. rates $300-$370; an M.S. $350-$450; and a Ph.D. $450 up. Those with four years experience are getting $600-$750. Very few engineers are unemployed. Some employers lure engineers by offers of bonuses and benefits, but starting salaries are fairly standard.

One personnel expert voiced something that everybody knew but nobody had come right out and said: "Engineers aren't changing jobs for peanuts; because a slight increase causes more income tax trouble than it's worth."

Nobody seems to be having any trouble with pirating although there seems to be a good deal of job switching. One personnel director puts it this way:

"Engineers aren't satisfied any more to proceed at a normal rate of progress, even with today's high wages. They change jobs because they want to skip a bracket, and be in a position two years after graduation that would normally take five years to accomplish, thus getting into a top salary position quicker. They really aren't thinking—a chemical engineer, you know, doesn't start thinking until he's about 35. I don't think they are doing themselves a heck of a lot of good in the long run."

As far as merit increases go, the West Coast seems to have a less definite pattern than the rest of the country. Some companies have no merit-raise programs but they see to it that their engineers get frequent cost-of-living increases, benefit from general increases coming out of labor contracts at other levels.

Other companies are careful to see that salary adjustments are made for men who have been with them a long time so that the pay differentials between the old and new men are kept in line.

A few companies have really tremendous variations in salary with some good young men making $15,000 to $20,000 a year, and some of the older ones making as little as $6,000.

In the Pacific Northwest, the situation shows "clean living." There is no indication of pirating. The only competition that the chemical companies object to is that offered by aviation companies. They don't necessarily pay higher wages, but they give "fringe" benefits such as a share in patent returns, on-the-job training, etc.

Chemical engineering graduates around Portland-Seattle are being offered up to $340 a month with B.S. degrees; $380 with an M.S., $525 with a Ph.D. There is no overtime work, no union and very little sentiment for one. Older employees do not object to higher starting salaries paid recent graduates because, as starting salaries move up, so do salaries all the way along the line.

## Significance

**THE PROCESS . . .**

**ELIMINATES present roasting, smelting, electrolytic and fire refining.**

**CUTS production costs by more than half.**

**SLASHES lag between mine and metal.**

**OPENS remote low-grade deposits.**

**EKES out production of older mines.**

## How It Works

**THE PROCESS . . .**

**LEACHES ore concentrates with acid or ammonia.**

**PRECIPITATES pure metals by direct hydrogen reduction.**

**PRODUCES metals as powders ready for pressing casting or extrusion.**

# Chemical Refining of Metals

**High pressures and high temperatures have been harnessed by Chemico's new autoclaving process. It will give us copper, nickel, cobalt and manganese dioxide. It's being considered for aluminum, chromium, uranium.**

A new process, completely chemical, may cut the cost of producing such strategic metals as cobalt, nickel and copper by more than half. The process bypasses roasting, smelting, electrolytic and fire refining.

Now that the barrier of atmospheric pressure and temperature has been broken through, almost limitless opportunities arise for the process. Pressures over 800 psi. have been tried, with correspondingly high temperatures.

It's possible, for example, using the new process, to get manganese oxide sinter from low-grade U. S. ores, thus freeing this country from dependence on foreign sources. Other possibilities: extraction of copper from scrap by a modification of the process, recovery from their ores of the oxides of aluminum, chromium, titanium and uranium.

### TRIO OF NEW PLANTS

Three big plants now being built at an aggregate cost of $25 million will use the process. Canada will get the largest one, the $17 million nickel refinery of Sherritt Gordon Mines Ltd. near Edmonton, Alberta. National Lead Co. has a $5 million plant under way at Fredericktown, Mo. And Howe Sound Mining Co. is putting up a $2.5 million cobalt refinery near Salt Lake City, Utah.

Another vitally important development that may soon find commercial application is a new process for production of pure copper from copper scrap, brass scrap or blister copper. It achieves virtually 100 percent extraction. The product, better than 99.9 percent pure, is oxygen-free and equivalent to high-conductivity electrolytic copper. Equally important is the almost complete recovery of zinc, a metal heretofore lost in scrap smelting operations. The process, an adaptation of the basic one for recovering metals from ore concentrates, was developed by Chemical Construction Corp. and Chemetals Corp. during two years of working together. Chemetals is currently working with Chemico on the recovery of manganese oxide sinter from low-grade U. S. ores.

### LEACHING AND REDUCTION

"Basically new and revolutionary," according to Major General William N. Porter, president of Chemical Construction Corp., the original process consists of pressure leaching of unroasted sulphide ore concentrates, an almost simultaneous oxidation step, and then direct reduction from aqueous solution of copper, nickel and cobalt as pure metallic powders.

Leaching can be done with either ammonia or acid, depending on the ore concentrate being treated. Howe Sound and National Lead will leach with sulphuric acid, while Sherritt Gordon will use ammonia, getting ammonium sulphate as a byproduct. Acid leaching operates at higher temperature and pressure, but the chemical reactions are more straightforward. It's likely to be used more widely than ammonia leaching.

The oxidation reactions are all exothermic. In fact, the steam and nitrogen given off can be used to operate the turboblower that blows air into the pressure vessels for the oxidation. In acid leaching, this direct evaporative cooling is all that is required. In ammonia leaching, however, cooling coils are used. The reduction reactions can be either endothermic or exothermic, depending on the temperature. They are usually exothermic at higher temperatures.

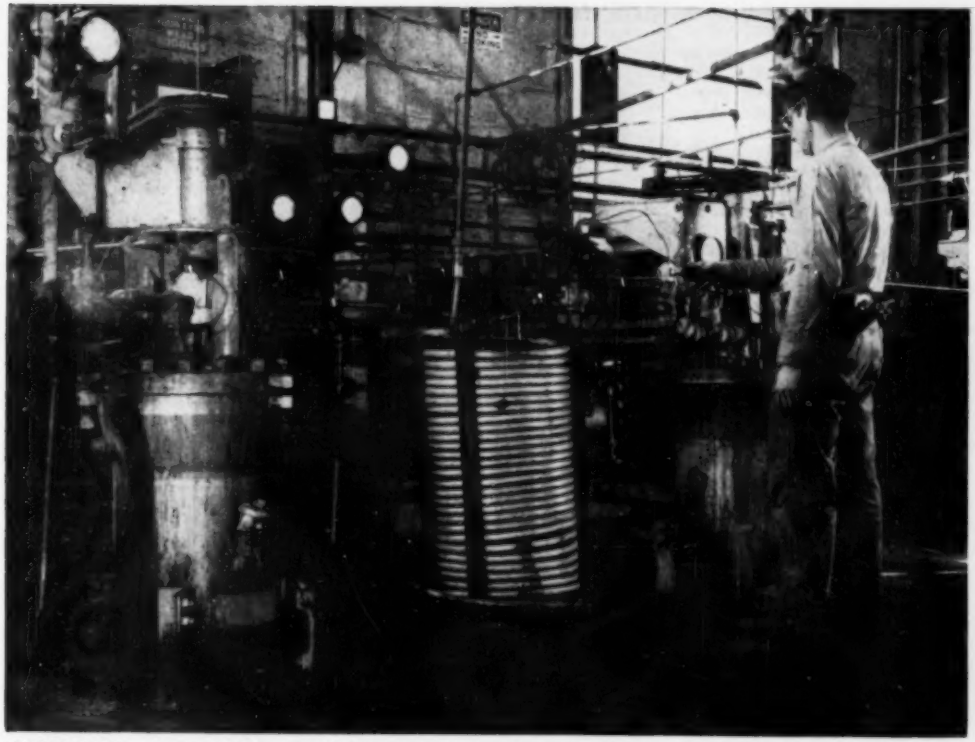
Reactions take place in big steel autoclaves, lined with acid brick. A silicone coating is applied to the inside of each steel vessel to insulate it from the hot brick lining and thus minimize corrosion. The autoclaves are mechanically stirred. They are fed by pressure pumps and discharged by pressure-regulated valves. The entire process is continuous and automatically controlled.

### SLASHES PRODUCTION COSTS

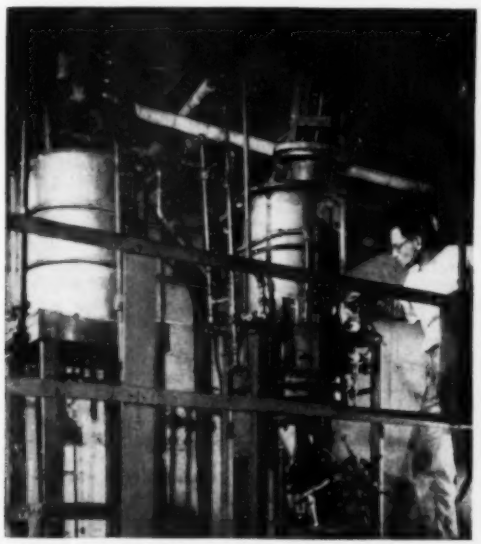
Compared with other smelting and refining methods, the Chemico process may cut production costs by more than half. Other advantages: sharply reduced transportation costs, fewer operating personnel, less time lag be-

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*Joe O'Connor, news editor of Chemical Engineering, here puts on his miner's cap and digs into the story of a new chemical refining process that opens a new era for metals.*



AUTOCLAVES are heart of high-pressure high-temperature process for reducing copper and precipitating it from leach liquor.



WASH TANKS in which leach liquor is removed from copper precipitate. Chemetals and Chemico operate Linden pilot plant.



ROTARY DRYER delivers oxygen-free high-conductivity powdered copper as Chemico's George F. Van Hare watches proudly.

tween production of concentrates and metal recovery.

Chemico's engineers figure that operating savings in three years might often be enough to cover the cost of scrapping an old smelting and refining plant and building a new one.

Because of reduced metallurgical costs it will now be possible, according to General Porter, to mine deposits of low-grade ores hitherto economically unattractive. "This," says Porter, "will permit a considerable increase in metals production to meet today's high demands."

At present, smelters and refineries are often hundreds of miles from the mines. By building the refinery at the mine, Porter emphasizes, freight charges could be slashed, and the lag between mining of the ore and production of pure metal cut from months to hours.

### COPPER AND ZINC FROM SCRAP

"Chemetals Corp.," General Porter says, "recognized that with the volume of copper and zinc contained in old and new scrap increasing rather than diminishing with the years, the tonnage recoverable under this newly perfected process could be compared with major domestic mining operations, unhampered by depletion considerations. By utilizing this process contaminated copper and zinc heretofore wasted due to difficulties in refining can now be freed."

Scrap recovery plants, often but one-quarter the size of a present smelter, could be built in each large industrial area, according to Porter. This would drastically cut transportation costs, a sizable factor in current metal prices.

Such plants could add significantly to the nation's output of copper. Of 35 copper mines in the U.S., 25 of the more important ones, with annual outputs ranging from 285,000 to 2,500 tons of copper, have an average yearly production of about 35,000 tons each. Ten scrap recovery plants, spotted strategically throughout the U.S., could each produce from 10,000 to 25,000 tons of copper a year, adding 100,000 to 250,000 tons a year to the U.S. total of high-purity copper.

It's a mistake, however, says President William M. Hayden of Chemetals, to expect that this process will immediately revolutionize present smelting and refining methods or make existing operations obsolete. "To the contrary," he declares, "it's a creative thing that will make possible the mining and chemical refining of heretofore uneconomic low-grade ore deposits, and the recovery of prime metals from industrial scrap, which otherwise would have been melted into inferior grades of ingot brass. These sources will one day replace depleted mining operations."

Hayden adds, "When the boom is over and demand slackens, costs will begin to make themselves felt. Then the savings in costs of the new process will show up. Why? Because small units, one-quarter or even one-sixth the size of present plants, will be able to carry on economic treatment of ore concentrates and scrap with their normal operating efficiency and normal costs."

### PROCESS IN CAPSULE

Refiners using the new process will first concentrate ore by conventional flotation methods. Then the concentrate, as a slurry, will be introduced into an autoclave designed to withstand high temperature and pressure. The vessel is equipped with an agitator. In the autoclave, the concentrate is leached with either ammonia or acid, then oxidized. From the resulting aqueous leach solution, metals will be recovered by suitable reducing agents. By varying conditions, individual metals can be separated as pure powders. These powders can be pressed, continuously cast or, as with copper, extruded. Reagents used in the process are recovered.

### HOWE SOUND'S COBALT REFINERY

While Sherritt Gordon's was the original, it won't be the first pressure leaching process to go into production. First commercial use will come next month when Chemico completes Howe Sound's $2.5 million cobalt refinery at Garfield, Utah. This plant will boost world output of strategic cobalt, most of which comes from the Belgian Congo, by more than 40 percent.

The plant will daily process 35 tons of 20 percent cobalt concentrate from Howe Sound's Blackbird mine near Cobalt, Idaho, resulting in yearly production of 2,000 tons of pure cobalt, about 40 percent of U.S. consumption last year. The government has contracted to take more than 10 million pounds of cobalt from Howe Sound over a five-year period. Actually, the government will get close to two-thirds of Howe Sound's annual output.

The Blackbird mine, originally staked as a gold mine in 1893, is today believed to be one of the largest cobalt deposits in the U.S. Its ore, high in arsenic, contains copper, iron, nickel and cobalt as sulphides and sulpharsenides.

### CONCENTRATING

At the Blackbird mine, Howe Sound's new concentrating mill, which can handle 1,000 tons a day, is already running. Ore is conditioned for a long time at elevated temperature before flotation. This makes possible a remarkably sharp differential flotation. Separate concentrates of copper, iron and cobalt are made in succession. The iron goes to tailing. The other two concentrates are shipped to Garfield, Utah, where the copper concentrate, containing about 25 percent, is processed at the Garfield smelter of American Smelting & Refining Co. The cobalt concentrate, containing about 20 percent, will go to Howe Sound's new refinery at Garfield.

The cobalt concentrate contains 20 times as much cobalt as it does nickel. Both are present as sulpharsenides. It also contains iron as arsenopyrite and copper as chalcopyrite.

### ACID LEACHING

At the refinery, the cobalt concentrate will be acid leached. No reagent sulphuric acid is required. Instead, sulphides in the concentrate are oxidized to sulphates. Iron in the concentrate becomes ferrous sulphate, which is oxidized to ferric sulphate. By hydrolysis from the aqueous solution, ferric hydroxide is precipitated. This, in effect, leaves hydrogen ions from the water and sulphate radicals from the oxidation of sulphides in the solution as sulphuric acid. Thus acid for leaching is actually made right in the autoclave. Instead of air, Howe Sound will use oxygen for the oxidation.

The autoclaves, of carbon steel clad with stainless, are lined with acid brick. All parts in contact with hot acid leach solution, such as injectors and agitators, are ductile titanium.

After leaching, the solution is filtered to remove the gangue and the troublesome arsenic as an insoluble iron arsenate. An interesting point: this iron arsenate precipitate can be dumped without damaging vegetation. Thus the Chemico process could open the way to economical working of gold arsenide ores in the U.S. and Canada. At present, arsenic in these ores has to be eliminated by roasting, which is expensive. The new process would make it easy to get rid of arsenic in these gold ores.

### SELECTIVE REDUCTION

Next, while the solution is still acidic, the copper is removed. Part of the product cobalt metal is recycled and used to cement out the copper. This metallic cobalt replaces the copper, which is thus reduced and comes down as metal. Howe Sound will produce about 300 lb. per day of this metallic cement copper. It will go to AS&R's Garfield smelter.

After the copper has been removed, the solution is made ammoniacal for reduction of nickel and cobalt. This is done with hydrogen under pressure. Nickel and cobalt precipitate together, and this mixture is recovered by filtration. Since the mixture contains only 5 percent nickel, and there's a ready market for it, Howe Sound at first won't separate the nickel from the cobalt.

With catalysts and at carefully controlled temperatures and pressures, metals in the electromotive series can be selectively reduced one after another. However, Chemico says it's probably impractical to recover metals above zinc in the series.

### ANOTHER ACID LEACHING PLANT

Like Howe Sound, National Lead will use acid leaching in its new $5 million refinery now being built at its Fredericktown, Mo., mine. When completed in mid-1953, the plant will handle 50 tons of concentrate per day. Each year it will turn out 700 tons of cobalt, 900 tons of nickel and 700 tons of copper, plus 7,500 tons of ammonium sulphate. Output will go to the government, which is financing acquisition of the new equipment.

Cobalt and nickel occur at Fredericktown with sulphides of lead, iron and copper. Ore will be separated by flotation into a lead concentrate, a copper concentrate and a nickel-cobalt concentrate. Using the new process worked out by Chemico, concentrates will be acid leached, oxidized with air, and the metals recovered by direct reduction. Like Howe Sound, National Lead will use titanium in parts exposed to the leaching solution.

### VAST CANADIAN ENTERPRISE

Up in Canada, Sherritt Gordon has under way a vast mining and refining project. At Lynn Lake, Manitoba, Sherritt has 14 million tons of proved ore, rich in nickel, copper and cobalt, mostly as sulphides.

To exploit the big deposit, Sherritt Gordon has persuaded Canadian National Railways to push through a 147-mi. railroad from Sherridon, Manitoba, to the mine at Lynn Lake.

To get power for the mine and concentrating mill at Lynn Lake, Sherritt Gordon is damming the Laurie River, diverting a neighboring stream into it, and erecting a 7,000-hp. hydroelectric dam downstream. Three other damsites, one at 7,000 hp. and two at 2,000 hp. each, have been picked for future development.

Ore concentrates from the mine will go to the $17 million nickel refinery that Chemico is building at Fort Saskatchewan, 12 mi. from Edmonton, Alberta. In its operation the plant will combine the Sherritt Gordon ammonia leach and Chemico's nickel reduction process.



**COPPER POWDER produced, better than 99.9% pure can be pressed or extruded.**

Slated to start operating in the fall of 1953, the plant will annually produce 8,500 tons of nickel, 1,000 tons of copper and 150 tons of cobalt, plus 70,000 tons of ammonium sulphate. Copper concentrate from Lynn Lake going to the Flin Flon smelter will bring Sherritt's total copper output to 4,500 tons a year.

### GOVERNMENT BIGGEST CUSTOMER

Sherritt Gordon will have no trouble marketing its products. Contracts with the U.S. government and with steel companies virtually assure sale of the entire output of nickel and cobalt and most of the copper for the first five years at prices current at delivery.

The U.S. government has contracted to buy 10 million pounds of refined nickel per year, or 60 percent of estimated output, for five years. During that period, the company, at its option, can provide an added 30 million pounds. Four steel companies have agreed to purchase 7.4 million pounds of nickel each over a five-year period, with deliveries starting in 1954.

The U.S. government agrees to take 25 million pounds of copper, 57 percent of annual output, for five years. Lynn Lake will produce 1.0 lb. of copper for each 1.9 lb. of nickel, and the copper production will come to about 12 percent of total sales.

Cobalt will also go largely to the U.S. government, which will take 750,000 lb. of refined cobalt, or 61 percent of output, for five years.

Canadian and export markets will have to be developed for the ammonium sulphate fertilizer, which sells for about $45 to $50 a ton on the Pacific Coast.

### FINANCING

To finance its project, Sherritt Gordon is raising over $41 million, a tidy sum to put into a mining venture in the wilderness of northern Manitoba, 147 mi. from track's end.

A breakdown shows Sherritt Gordon will spend roughly $12 million on the Lynn Lake mine and concentrating mill; $3.4 million on the Laurie River power development; $16.8 million on the chemical metallurgical plant at Fort Saskatchewan; $1.6 million on metallurgical research; and $7.1 million for working capital, contingency reserve and other expenses.

Not included in the Sherritt estimates is the $15 million that the Canadian National will spend to lay track the 147 mi. from Sherridon to Lynn Lake. A high rate classification will be in effect for 20 years. However, after 1,880,000 tons have been shipped the rate will be trimmed $2.65 per ton until $5 million has been refunded to Sherritt Gordon.

### RESEARCH COST

By the time the job is finished, Sherritt will have spent over $1.5 million on metallurgical research. This equals its total profit in 1951, best year in its history.

Most of the research money went into the Ottawa pilot plant, supervised by General Manager H. H. Hales and under the direct charge of C. A. Hames, manager of metallurgical research. The Ottawa pilot plant employs 90, about half being technical men.

### PROJECT ENDORSED

Sherritt has enlisted as partner the astute Newmount Mining Corp., successful throughout the world in sizing up new mining ventures. A report by Ford, Bacon & Davis, Inc., consulting engineers, confirms Sherritt Gordon's estimate of ore reserves and figures on plant costs and operating expenses. Battelle Memorial Institute of Columbus, Ohio, reports the chemical process for refining nickel and cobalt,

recovering copper sulphide and producing ammonium sulphate is technically sound and should produce marketable products.

Nickel and copper in the ore will be separated by flotation in the concentrating mill at the Lynn Lake mine. To save on transportation, copper concentrate will go to the Hudson Bay smelter at Flin Flon. The flotation nickel sulphide concentrate, which also contains cobalt and copper, will be shipped to the Fort Saskatchewan refinery.

### TWOFOLD PROCESS

Combining Sherritt Gordon's ammonia leach with Chemico's nickel reduction, the refining process eliminates roasting of the concentrate before leaching and produces, instead of nickel oxide, pure nickel powder.

Economical operation requires cheap ammonia and cheap fuel. Alberta's abundant natural gas will provide both. The refinery will have its own ammonia plant.

In the process, nickel, copper and cobalt are leached directly from the sulphide concentrate with strong aqueous ammonia, followed by oxidation with air. Next, copper is precipitated from the leach liquor as sulphide. Then nickel and cobalt, in turn, are separately reduced and precipitated as powdered metals. Ammonium sulphate is recovered.

Nickel concentrate from the mine contains about 11 percent nickel and 2 percent copper. It is finely ground, about 85 percent being −200 mesh. Unless it has solidified during its trip to the refinery, it requires no regrinding before it's fed to the first step of the leaching process.

Leaching is done in steel autoclaves equipped with agitators. Alloy steel parts must withstand corrosive liquors. Even so, the Sherritt Gordon plant, unlike the other two, uses no titanium.

Leaching takes place in a two-stage countercurrent cycle. Residue from the first autoclave is fed to a second, and from there is discarded to waste. Leach liquor from the second autoclave is returned to the first. It is from the first autoclave that liquor is drawn off for recovery of metals. At the Ottawa pilot plant, which handles 1½ tons of concentrate a day, total leaching time is about 30 hr.

Nickel concentrate goes into the first autoclave, where it's leached with strong ammonia solution, then oxidized with air. Heat from the exothermic reaction, together with pressure, increases the leaching rate. Pressures range from 60 to 100 psi., while large volumes of cooling water keep the temperature at 170 deg. F.

Leaching and oxidation convert metallic sulphides into amines of the metals, and they go into solution. Amine sulphates are formed, together with thiosulphates and dithionates.

### IRON PRECIPITATES

Iron, often a useless and costly nuisance in sulphide ores, is oxidized early in the process. It precipitates and is contained in the residue discarded from the second autoclave. This residue carries about 48 percent iron, 1.5 percent nickel and 0.5 percent cobalt. So far, Sherritt Gordon has no profitable iron product, but current research points to commercial use of this finely divided iron precipitate.

Thickening and filtration at atmospheric pressure separate residue from the pregnant solution. The pregnant leach liquor contains, in solution, the copper, nickel and cobalt.

### RECOVERING COPPER SULPHIDE

First, copper is removed. Heat decomposes the unsaturated sulphur compounds in the leach liquor, and causes the copper to precipitate out as copper sulphide. It's recovered by filtration. Sherritt Gordon will probably sell this copper sulphide, but if economics warrants it can produce copper sulphate. And research most likely will lead to production of pure metallic copper. Any precious metals in the ore concentrate can be recovered with the copper.

### REDUCING NICKEL AND COBALT

Next comes the reduction of nickel and cobalt. First nickel and then cobalt, in separate steps, are reduced by hydrogen at pressures between 300 and 600 psi. and precipitated individually as high-purity powdered metals.

This is one of the most ticklish steps in the entire process and calls for careful control of pressure, temperature, concentration and catalyst. Even though there's less than a third of a pound of cobalt per ton, Sherritt Gordon each year will produce 150 tons.

### CRYSTALLIZING AMMONIUM SULPHATE

Most of the sulphur, present in the original concentrate as sulphides of the metals, winds up in solution as sulphates or as elemental sulphur. After the metals have been removed, much of the sulphur is recovered from the leach liquor by crystallizing ammonium sulphate out of the end barren solution as a byproduct. Ammonia will be recycled.

### COPPER SCRAP PROCESS

While Sherritt Gordon was launching this huge nickel project in Canada, another group of mining and metal men here in the United States was quietly at work with Chemico on the chemical recovery of metals from brass, bronze and copper scrap, old and new alike. They had enough faith in American Cyanamid, Chemico's Edward S. Roberts and their own judgment of the potential economies of the process to gamble their futures and three-quarters of a million dollars to make the process a commercial reality.

That they succeeded is evident. Chemetals, the company they organized, has just successfully demonstrated the copper scrap process as carried out at Chemico's Linden, N. J., pilot plant to over a dozen U. S. concerns, among them the largest producers and fabricators of non-ferrous metals and major electrical manufacturers. In addition, top non-ferrous metals experts from Great Britain, Brazil, Sweden, France and Australia have seen the process in operation.

### HOW SCRAP PROCESS WORKS

Essential steps of the copper scrap process are: (1) leaching scrap with cupric ammonium carbonate solution; (2) filtering leach solution; (3) reducing leach solution in an autoclave at high temperature and pressure; (4) washing and drying the copper powder; (5) recovering zinc when present; and (6) recovering other metals, such as tin, manganese and lead, as oxide slimes.

Baskets of scrap are immersed in leaching solution, where scrap is dissolved. The copper scrap is leached with ammoniacal cupric carbonate solution at 135 deg. F., the cupric ion being reduced to cuprous.

Since the cupric ion is the active agent in dissolving the scrap, it's essential to keep a high concentration of cupric ion at the start of leaching. This is done by passing recycle liquor through a column where cuprous ion is reoxidized with air to cupric for further leaching.

### REDUCTION WITH MONOXIDE

When enough copper has been dissolved, the leach solution is filtered, run into an autoclave, heated up to 300 deg. F. and reduced with carbon monoxide under 900 psi. This precipitates copper metal.

At the end of this 60-min. reduction step, precipitated copper powder and mother liquor are blown over to a decanter. The copper powder is separated from the liquor.

Next, the powdered copper metal is successively washed with dilute ammonia, water, dilute acetic acid, dilute

(Continued on page 368)



PEELING A FILTER PRESS. Neoprene-treated paper is replacing cotton duck and saving thousands of dollars a year at Du Pont's plant in Deepwater, N. J. In this press, it is used along with cloth, doubles the life of the cloth.

# Throw-Away Filter Medium

**New neoprene-treated filter paper has a high wet strength and good chemical resistance. It can replace cotton duck in many services, or may be used with duck. Costs 1/15 as much.**

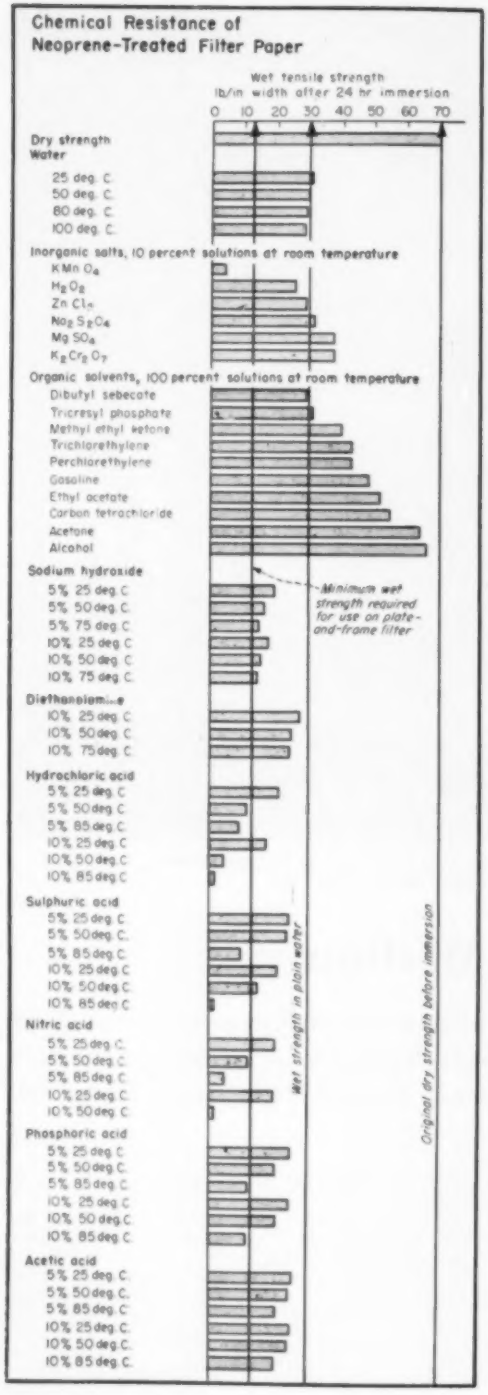
**FRANCIS O'SHAUGHNESSY**

Used in the right places, neoprene-treated paper is an economical substitute for cotton duck on plate-and-frame filters. Eighteen months ago, here at Du Pont's Chambers Works, Deepwater, N. J., tests began on the new filter medium. Today's evaluation: Physical and chemical properties are adequate for many services and the new paper has cut the total annual cost of filter media by some 10-15 percent.

Claremont Paper Co., Claremont, N. H., makes the paper. Called Netone-5 Filter Paper, it is a 100-lb. porous kraft containing 5 percent neoprene synthetic rubber.

Added as latex to the paper pulp, the neoprene gives wet strength to the paper. Moreover, it is sufficiently resistant to chemicals to allow the paper to stand up in presence of dilute acids and alkalis. In round numbers, the paper costs about 5 c. a sq. yd. compared to 75 c. for cotton duck, and may be used alone or in combination with cotton cloth.

FRANK O'SHAUGHNESSY *is a chemical engineer at Du Pont's Chambers Works, Deepwater, N. J. He recently completed the first field evaluation of neoprene-treated filter paper.*




TEST CASES

1. **Liquid Product:** Formerly dressed with a single layer of cloth, a press (above) could only use a cloth once because of chemical attack.

First a single paper was tried in place of a single cloth. It was satisfactory except that sharp scale in the slurry occasionally punctured the paper. Double papers were then tried. This reduced the number of punctures, but did not eliminate them.

Present practice: a single paper over a single cloth. The cloth acts as a backstop and catches any solids that get through a puncture. While the paper, which is used only once, protects the cloth and permits its use a second time.

2. **Cake Product:** Formerly, to reduce bleeding, each plate was dressed with a single sheet of untreated industrial filter paper sandwiched between two cloths. Cloths and papers were reused 8 to 10 times without removal from the press.

As a test, the press was dressed with one sheet of neoprene treated paper over one cloth. This gave adequate filtration characteristics but the paper was often torn when the press was scraped.

Now, one sheet of treated paper is used under one cloth. Results are satisfactory. Papers and cloths are still reused as often as before without removal from the press. Since there is little difference in the cost of the treated and untreated papers, almost the full value of the eliminated cloth is saved. As a bonus, flecks of paper no longer turn up in the cake as they did when the untreated paper was used.

GENERAL PRINCIPLES

**Paper vs. Cloth:** Cloth has a short life. Blinding, chemical deterioration, or some special condition such as changing from one dyestuff color to another usually cause short life.

Where cloths are used somewhere between five and fifteen times, other factors enter. In clarifications, for example, where the cake is discarded, paper is often preferred because it makes the press easy to unload. It is simply slit along the top and peeled down into the pan as shown above. Again, because it's a good gasket, the paper prevents loss of solvent caused by wicking. Paper may also be favored where cloth cleaning is difficult and labor consuming, or where valuable material is occasionally lost because a cloth, used once too often, breaks.

On the other hand, where it can be used only once, paper must be charged with the labor cost of redressing the press each time, whereas cloth need only be scraped and left on the press for the next filtration.

Rather than spend time worrying about these factors, try the paper on half a dozen plates and see if any of these advantages or disadvantages prove important. It's the most practical approach.

**Favorable Condition:** Cloths are often used double. It is possible and frequently cheaper to replace one of the cloths with paper.

Usually the paper goes under the cloth to protect the paper from tearing when the plates and frames are pulled apart or when spatulas are used for cleaning. However, at times the paper should go over the cloth, as in Case 1. Here the paper protects the cloth, tearing is unimportant because the paper is discarded.

Incidentally, in all this discussion I mean cotton cloth, not special materials like nylon or other synthetic fibers. The paper has little chance of displacing these fabrics, which are not used unless they give exceptionally long and economical service.

So much for economics. Note again the key words, the things to look for: chemical deterioration, bleeding, blind-

ing, double cloths, wicking, cloths used fewer than five times.

**Chemical Resistance:** The data and conclusions ventured here should be applied cautiously. They are only opinion based on limited experience in one plant. It would be a great mistake, on their strength alone, to plunge into large-scale use of the paper. Preliminary tests and small-scale plant trials are easy to make and cannot be recommended too highly.

Original dry strength of the paper is about 70 lb. per in. of width; immersion in water reduces it to 30 lb. per in.; and as a rough guide, we take 12-13 lb. per in. as the minimum wet tensile required for usefulness and safety in the majority of plate-and-frame filters.

In water, strength is well over the minimum and shows only slight decline as the temperature is raised to the boiling point.

In salt solutions, other than strong oxidizing salts, the paper appears to be as strong as it is in plain water, judging from a few solutions tested at room temperature and 10 percent concentration. Although there are few data to confirm it, it is reasonable to suppose that the paper would work just as well in other non-oxidizing salts or at higher temperatures or at higher concentrations.

In strong oxidizing solutions, the paper is deteriorated rapidly and severely. It should not be used, for example, with solutions of potassium permanganate or hot nitrous acid. Note, however, that the paper's strength was well over the minimum in a 10 percent solution of hydrogen peroxide at room temperature.

Organic solvents weakened the paper even less than water, which, remembering its good gasketing efficiency, makes the paper an excellent candidate for solvent filtrations. Although these solvent tests were made at room temperature, the paper probably would also be usable at higher temperatures.

Alkaline solutions weakened the paper more than water but less than acid. Laboratory tests indicate the paper can be used with 10 percent sodium hydroxide or 10 percent diethanolamine at temperatures up to 80 deg. C.

In acid, the paper is weakened more than in water, but its strength is adequate if the acid is dilute and not too hot. The paper's acid resistance is superior to other commercial wet strength papers—an advantage of neoprene as the binder rather than a hydrolizable resin.

Don't use this paper in these solutions where the temperature is above . . .

| | In 5% Acid | In 10% Acid |
|---|---|---|
| Hydrochloric acid | 45 deg. C. | 30 deg. C |
| Nitric acid | 45 | 30 |
| Sulphuric acid | 80 | 50 |
| Phosphoric acid | 80 | 75 |
| | In 5% Acid | In 10% Acid |
| Acetic acid | 80 | 80 |
| | In 5% Caustic | In 10% Caustic |
| Sodium hydroxide | 80 | 80 |
| Diethanolamine | 80 | 80 |

Make no mistake: the addition of 5 percent neoprene to paper does not work miracles. All that can be said is that the chemical resistance of the neoprene paper is at least as good as that of paper fibers. And any chemical that does not destroy the fibers will not destroy neoprene's effectiveness as a binder.

But don't expect, as some have, that the neoprene has enveloped each fiber and made it immune to chemicals that attack cellulose. Chemicals that attack ordinary paper or cotton duck will also attack neoprene-treated paper.

**Filtration Properties:** Pore size is comparable to No. 8 or No. 10 cotton duck. According to lab measurements, air permeability is lower and water resistance slightly higher than cotton duck, predicting lower filtration rates.

In service, this has proved to be true in some cases, not in others. Where the cake is free filtering or is never allowed to become very thick, filtration rate is lowered, in some instances as much as 15 percent. Where the cake resistance is high, the cake itself soon becomes the controlling factor. Over-all filtration rate is not reduced much when the paper is substituted for duck.

**Pressures:** For us the paper stood a maximum filtering pressure or blowing pressure of 25-30 psi. In one case, the paper withstood pressure up to 40–50 psi.

**Tearing:** Several things will tear the paper.

1. Unless the paper has cloth over it, it frequently sticks to the frame and tears when the press is opened.
2. If the plates and frames are cracked and splintery or roughened by corrosion, there is danger of tearing the paper.
3. Scale or other sharp objects in the slurry may puncture the paper. If justified economically this can be nullified by use of paper and cloth together, as was done above.
4. If steel spatulas are used for cleaning, it is difficult to avoid tearing the paper. Wooden spatulas are much to be preferred.

**CONSIDER CLOTHS:**

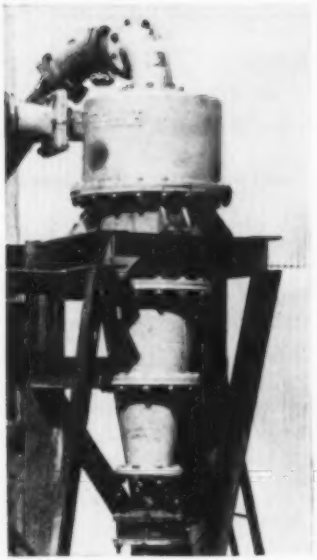
**You may save money . . .**

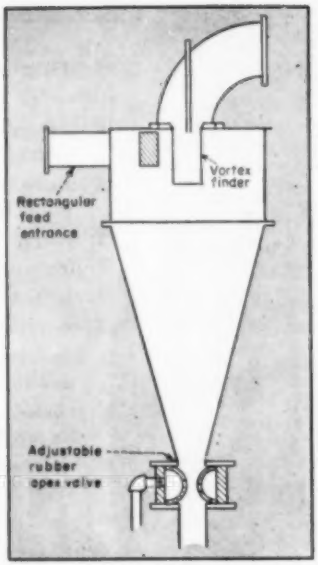
- **If present cloths are used less than 10 times.**
- **If cloths are not nylon or other special material.**
- **If annual cost of present cloths is high.**
- **If double cloths are now used.**
- **If cloth washing is a problem.**
- **If chemical deterioration is a problem.**
- **If bleeding, blinding or wicking is a problem.**
- **If tearing hazards are not present or can be nullified economically.**
- **If filtering or blowing pressure is less than 40 psi.**

**CONSIDER FILTRATE:**

**You may save money . . .**

- **If it is water or neutral solution or solvent up to 100 deg. C.**
- **If it is 10 percent caustic soda up to 80 deg. C.**
- **If it is 10 percent active acid (hydrochloric, nitric) up to 35 deg. C.**
- **If it is 10 percent weak acid (acetic) up to 80 deg. C.**
- **If it is not strongly oxidizing.**
- **If it is not hot, concentrated alkali or acid.**






# Controlling Separation in Liquid-Solid Cyclones

**The following variables are the most important in determining for solid-liquid cyclones what we ask first about any classifier: What separation will it make?**

**E. B. FITCH and E. C. JOHNSON**

By now most engineers have heard of the Dutch State Mines or liquid-solid cyclone. However, not too much is known about the various factors involved in controlling separation in these cyclones. Separation or "mesh of separation" means specifically the size of the largest particles which appear in the overflow in any significant quantity.

The figure shows the unit in cross-section. The feed enters through the rectangular feed entrance. The coarse, heavy particles are thrown centrifugally to the periphery and make their way down the wall to the apex where their rate of discharge as underflow is controlled by an adjustable rubber apex valve. As the apex diameter is decreased the solids build up behind the valve producing a denser underflow. Meanwhile, the fine particles are swept into the upward flowing vortex stream which exists as overflow through the vortex finder.

Given a series of cyclones geometrically similar except for the sizes of the feed, overflow, and underflow orifices, the following have been found to be significant variables in determining the mesh of separation produced: (1) size of feed entrance and vortex finder, (2) size of cyclone, (3) specific gravity of feed solids, (4) quantity and size distribution of feed solids, (5) pressure drop or head loss across cyclone, and (6) plasticity of feed.

E. B. FITCH and E. C. JOHNSON are engineers with the Dorr Co., which concern manufactures under license the Dutch State Mines cyclone in this country. This article is based on their paper given before the American Institute of Mining and Metallurgical Engineers, New York, Feb. 20, 1952.

**Table I—Separation with Various Fittings**

3" separator, operating on a dilute suspension of minus 65 mesh dolomite solids in water, fed into the cyclone at 20 psi.

| Area of Feed Entrance, Sq. In. | Diameter of Vortex Finder, In. | Separation in Microns |
|---|---|---|
| 0.75 | 1.05 | 34 |
| 0.53 | 0.82 | 28 |
| 0.30 | 0.62 | 24 |
| 0.19 | 0.49 | 23 |
| 0.10 | 0.36 | 27 |

### SIZE OF FEED ENTRANCE AND VORTEX FINDER

Prime adjustment for mesh of separation is the size of the feed entrance and vortex finder. Larger fittings give coarser separations. Smaller fittings, down to a certain optimum size, give finer separations. However, in any given size of cyclone, making fittings any smaller than this certain optimum size results in coarser separations again, rather than in finer ones. For minimum mesh of separation in any given size of cyclone, the feed entrance and the vortex finder usually have equivalent diameters in the range of one-fifth to one-sixth of the diameter of the cyclone. However, this has been observed to vary with the nature of the feed slurry.

To illustrate the effect of changing the feed entrance and vortex finder, Table I shows the separations obtained in a 3 in. cyclone operating on a dilute slurry of minus 65 mesh dolomite solids. The operating pressure was constant at 20 psi. In every case the feed entrance has an area essentially equal to that of the vortex finder. Each point is the average value for from seven to nine individual runs.

### SIZE OF CYCLONES

Smaller cyclones can make finer separations than are possible in larger ones. On the other hand, they cannot be fitted to give as coarse separations as are possible on larger ones. This will be apparent when we give the data on the range of separations possible with the different sizes of cyclones. Thus the minimum separation obtained with a 12 in. cyclone under the conditions as specified for Table I was 37 microns, as compared to the minimum of 23 microns shown in Table I for the 3 in. unit.

### SPECIFIC GRAVITY OF FEED SOLIDS

It is obvious that the specific gravity of the solids affects the separation size. The correlation[1] showing separation inversely proportional to $(\rho_s - \rho)^{\frac{1}{2}}$ has proved satisfactory.

### QUANTITY AND SIZE DISTRIBUTION OF SOLIDS

The mesh of separation obtained in a cyclone is strongly affected not

Table II—Effect of Dilution on Separation

| Volume of Dilution in Overflow | Wt. Percent Solids in Overflow | Separation, Microns |
|---|---|---|
| 4 | 42 | >147 |
| 5 | 37 | 60 |
| 6 | 32 | 43 |
| 10 | 22 | 36 |
| 20 | 13 | 32 |
| Very high | Low | 29 |

Table III—Percent Solids at Volume Dilution of 8

| Specific Gravity of Solids | Solids, % |
|---|---|
| 1.3 | 14 |
| 2.0 | 20 |
| 2.7 | 25 |
| 3.0 | 27 |
| 4.0 | 33 |
| 5.0 | 36 |

only by the quantity of solids in the slurry treated, but also by the size distribution of the solids.

As the solids become crowded in a slurry the particles interfere with one another and it becomes more difficult for them to settle. The mesh of separation becomes coarser. Increasing coarseness of the solids also coarsens the mesh of separation.

The effect of dilution is illustrated qualitatively by the above data. In this case the feed was a minus 325 mesh dolomite slurry of varying dilution. A 12 in. cyclone was used. Separation is here correlated with overflow dilution, although it is not established that this is the best correlation to use. In Table II volume dilution is defined as the volume of liquid in a slurry divided by the volume of solids.

While it is not safe to draw any quantitative conclusion from the above table, it is clear that as the solids become crowded in a slurry, the separation becomes rapidly coarser.

It has been our experience that the effect of dilution can usually be disregarded for purely practical purposes until the volume dilution of the feed drops below about 8. At some dilution less than this it starts to become very important. At just what dilution the rapid increase in diameter-of-separation sets in seems to depend upon the size of the unit, the fittings used, and probably upon the coarseness of the solids. The following table shows the weight percent solids at a volume dilution of 8 for solids of different specific gravities.

Practically, if the percent solids in a slurry is much higher than shown in Table III, separations substantially coarser than those to be mentioned below must be anticipated.

The effect of coarseness of feed can be seen from the following examples. Under essentially identical operating conditions, a 3 in. unit gave a 23 micron separation when treating minus 65 mesh dolomite solids, and a 16 micron separation on minus 325 mesh solids. A 12 in. unit gave a 37 micron separation on minus 65 mesh dolomite solids, and a 29 micron separation on minus 325 mesh solids. Even though the difference in feed did not appear to be great, there was a substantial difference in the separation.

From the above, it will be apparent that separations in a cyclone may be made substantially finer if the feed is first scalped of coarse particles. The scalping device may be another cyclone.

### PRESSURE DROP THROUGH CYCLONE

Increasing pressure gives finer separations. As a generality the diameter-of-separation seems to vary inversely as about the fourth root of pressure. Thus doubling the pressure would give about a 16 percent decrease in the diameter-of-separation.

Actually, the direct data we have available at this time are not consistent enough to permit any accurate evaluation. Practically, separation is made finer by increasing pressure, but it takes big changes in pressure to make a noticeable difference. An exception may exist in the treatment of plastic pulps.

### PLASTICITY OF FEED

If the pulp solids contain more than 2 or 3 percent undispersed clay or claylike solids, the pulp will usually be significantly plastic. In general, separations on plastic pulps will be from one to many meshes coarser than would be obtained on non-plastic slurries. Increasing pressure is particularly beneficial in treating plastic pulps, because the increasing centrifugal forces thus obtained aid in causing particles to tear their way through the plastic structure of the solids. Therefore the diameter-of-separation may decrease more rapidly than normal with plastic pulps, and at very high pressures, as in the range of 70 psi., the separation may often approach that for non-plastic slurries.

A plastic pulp may usually be recognized by the fact that an object comes out with a paint-like covering coat of solids after being dipped in it.

The separation ranges given in Table IV are valid for the condition that the feed comprises dilute suspension of minus 65 mesh non-plastic solids, fed through the cyclones at a head of 50 ft. The ranges are covered by changing the feed entrance areas and the vortex finder diameters. The separation will deviate from the given ranges with changing conditions as described above.

### SHARPNESS OF CLASSIFICATION

Mesh of separation does not tell the whole story on classification. The next question is how sharp a classification is produced. How free from fines is the coarse product or underflow.

Sharpness of classification is also dependent upon many factors, but under fixed process conditions, is controlled by the setting of the apex valve. The higher the percent solids in the underflow, the sharper the separation. However, the mesh of separation coarsens and is uncontrollable is the apex valve is closed so far that a rope discharge is obtained.

To obtain a sharp classification then, the apex valve should be adjusted to give as dense an underflow as possible without rope discharge. This is particularly important when making fine separations, which call for small diameter units, with small fittings and high operating pressures.

In desliming effectiveness, the cyclone can approach an ordinary raking classifier. It can be substantially more effective than an hydroseparator. Under comparable conditions, a raking classifier might give from 22-28 percent water in the underflow, a cyclone could give from 27-30 percent water, and an hydroseparator would give in the range of 50 percent water. Therefore, a cyclone, if operated with as thick an underflow as feasible, will have in its underflow about the same percent of slimes as a raking classifier, but only about 60 percent as much as obtained from an hydroseparator. It can be seen that if desliming is desired, the underflow from a cyclone, or any simple sedimentation classifier, must be run as thick as feasible.

In ordinary gravity sedimentation, little control can be exercised over the disposition of the critical sizes. In a cyclone, on the other hand, the split of critical sizes between the underflow and the overflow is strongly affected by operating conditions. A cyclone can be operated to give a separation much

(Continued on page 203)

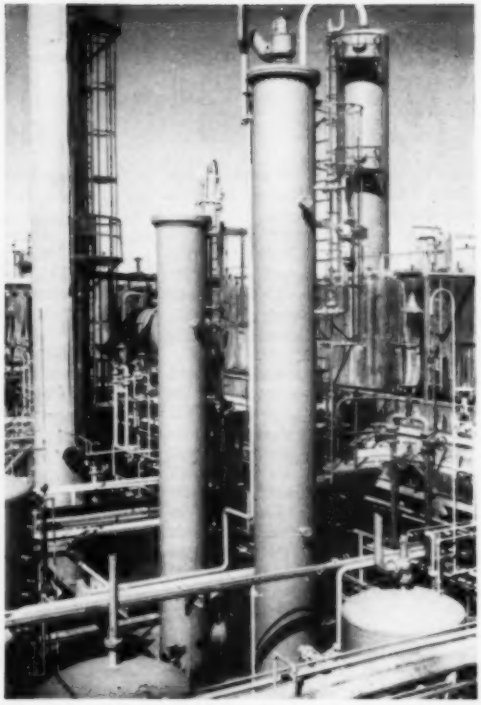
Table IV—Flow and Separation Ranges

Dilute, non-plastic slurry feeds of minus 65 mesh solids of various specific gravities suspended in water, operating at a head of 50 ft., with various feed entrances and vortex finders.

| Cyclone Diameter, In. | Feed Flow, gpm. | Separation 1.35 Sp. Gr. Solids, Micron | Separation 2.7 Sp. Gr. Solids, Micron | Separation 4.0 Sp. Gr. Solids, Micron |
|---|---|---|---|---|
| 3 | 6–46 | 80–85 | 22–40 | 17–30 |
| 6 | 43–152 | 62–100 | 28–45 | 21–33 |
| 12 | 160–550 | 82–128 | 37–58 | 28–44 |
| 24 | 465–1490 | 115–150 | 52–67 | 40–50 |



SIEVE TRAYS FOR DISTILLATION—Success of this 6-ft.-60-trays column encouraged new Celanese installations.



AND FOR EXTRACTION—Liquid-liquid extractor with sieve trays allows more extraction stages than ring and disk type.

# Parlaying Profits From Process Data

**Celanese did with such plant innovations as sieve instead of bubble-cap trays, thermo-siphon instead of kettle-type reboilers, air instead of water-cooled exchangers**

Celanese engineers are weaving improvements in unit operations throughout the company's new Canadian petrochemical plant. They've based many of their tricks on data gathered at Bishop, Tex., where the company operates a similar plant.

To be run by a subsidiary, Canadian Chemical Co., the $54 million project will be completed this year. Oxidation of light hydrocarbons will produce a complex mixture of organic chemicals. A series of diffusional operations will then separate them to meet commercial purity standards.

Innovations at Edmonton include:

1. The use of sieve trays instead of bubble caps in most of the plant's 60 distillation towers. Researchers found the trays had 20 percent greater efficiency. Additional advantages of the sieve tray column include simpler construction, lower cost, easier maintenance and higher capacity.

2. Sieve trays will also be used for contacting the two liquid phases in liquid-liquid extraction. For a given height of extractor they allow installation of about 50 percent more extraction stages than the ring and disk.

3. Thermo-siphon reboilers will replace the kettle-type, halving the heat transfer surface per tube bundle.

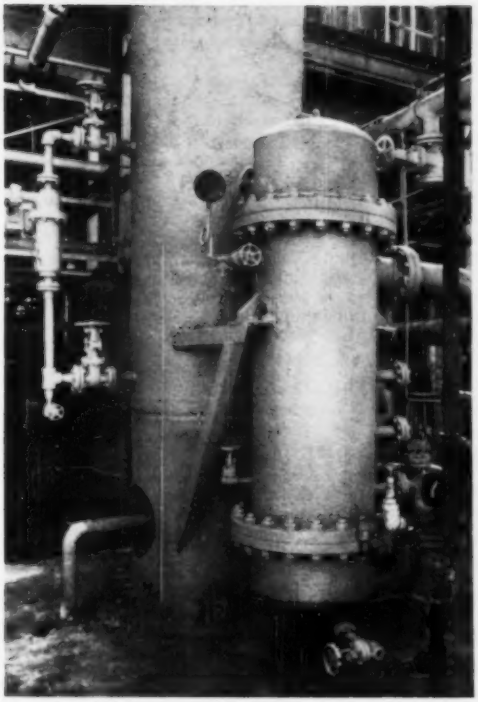
4. Pumps and instrumentation have been standardized for utmost flexibility within the plant, minimum investment in spare parts.

Celanese has still another ace—air-cooled exchangers. These will not be used at Edmonton but at a new Pampa, Tex., plant where there is a water supply problem.

### SIEVE TRAYS FOR DISTILLATION

Both Bishop and Edmonton plants make extensive use of all kinds of distillation. In the early operation of the Bishop plant, engineers had a hard time operating fractionating towers on compounds with which most of them had had no previous experience. Increases in the capacities of these towers were made by rearranging flow patterns

DAVID R. KECK *is assistant manager at Celanese's new Edmonton plant.* *The material for this article was taken from his paper delivered before the Chemical Institute of Canada in Hamilton, Ont., on March 2, 1952.*



THERMO-SIPHON REBOILERS—To replace kettle-type in Celanese's new Edmonton plant, they halve heat transfer surfaces.



AIR-COOLED EXCHANGERS—These will be used at a new Pampa, Tex., plant where there is a water supply problem.

and blanking bubble caps according to published procedures.

They were not, however, completely sure of some of the calculation methods for predicting performances of bubble trays. For this reason a 6½ ft. diameter experimental tray, equipped with an 800 gpm. pump and a 16,000 scfm. air blower, was installed to get performance data.

With this information on bubble trays available, they decided to install a sieve tray or perforated tray in their experimental unit for comparison. After a search of the published data on sieve trays, they worked out a hole pattern and fabricated the tray. It didn't take long to see that operation of this tray was very superior to that of the experimental bubble tray. Management agreed to the installation of sieve trays in a 6-ft. diameter, 60-tray tower, which was being added to the purification unit at that time.

All experimental data were obtained on air and water. So the engineers set up a plant scale installation to study relative efficiencies on two alcohols with known relative volatilities. An idle 2-ft. diameter bubble tray column was operated concurrently with the sieve tray column. Sieve tray efficiency proved to be 20 percent above that of the bubble tray. Efficiency of the sieve tray did not vary over the experimental range covered as the operating load in the column changed. Unfortunately, the boiling range of the test mixture, n–propanol—secondary butanol, was higher than the design liquid and it was impossible to run the sieve tray column up to maximum capacity due to limitations in reboiler capacity. (Bubble tray efficiencies are low at low throughputs, rise to a maximum and then fall off again at high throughputs.) Armed with these data, Celanese put in the 60-sieve tray tower at Bishop which has operated satisfactorily for about two years.

Company engineers feel that their sieve trays offer about 15 to 20 percent higher capacity than a bubble tray of the same diameter. The absence of hydraulic gradient on sieve trays is one of the reasons for their greater throughput.

However, certain limitation make it necessary to use bubble trays in some cases. These are high vacuum and distillation under extreme foaming conditions. To get good distribution of the vapors through holes in the trays it is necessary that at least 2 in. of liquid pressure drop be maintained on all sieve trays. For this reason its use is limited in vacuum service.

If one were to set out to make foam, one would employ a large number of small holes with vapors passing through the holes as in a fritted gas tube. While Celanese uses holes larger than those in a fritted gas tube, the principle is the same. They feel that the extreme number of small holes in the sieve tray is the contributing factor to its higher efficiency since the objective in a fractionating tower is to get intimate contact of the vapors and liquids.

Celanese uses 3/16-in. thick carbon steel plate and 3/16-in. diameter holes. They are now operating about six sieve tray columns at Bishop with diameters up to 8 ft. Their new plant at Pampa, Tex., will be predominantly sieve tray tower and about three fourths of the towers at Edmonton will have sieve trays.

### AND SIEVE TRAYS FOR EXTRACTION

At Bishop, engineers noted low efficiencies in ring-and-disk-trays liquid-

liquid extraction operations. Available data showed that some people were employing perforated trays of various kinds for contacting the liquid phases. Since Celanese had no specific data, they built a pilot plant with perforated trays inside of glass bell and spigot pipe. Preliminary information obtained on this 2-in. column was used to design a 6-in. diameter glass column. Data obtained on the larger column encouraged installation of the perforated trays in all of the company's new and most of their existing liquid-liquid extractors.

In the tray downcomers or upcomers are installed depending upon the direction of the flow of the continuous medium. They are similar to downcomers in fractionating columns. With the continuous phase flowing down the column, the dispersed phase collects beneath the tray. It is forced up through the holes into the continuous medium at a velocity above the streaming velocity, but slow enough to permit individual droplets of uniform size to form as the liquid passes into the continuous phase above. Bypasses provide for any emulsion which builds up between the phases or in case the flow of the dispersed phase exceeds the capacity of the trays.

Early installations of sieve trays were made by using drilled trays. However, the drilling cost for each succeeding installation was about 50 percent higher, and it is now the practice to buy mechanically perforated trays. If too many holes are present in any portion of the tower, they are blanked off by tack welding thin strips of the same kind of material over them. This trick fits in well with the company's standardization program within the plant. It permits all sieve trays for a given tower diameter to be perforated to the same pattern and the exact number of holes to be provided by blanking off.

### THERMO-SIPHON REBOILERS

Another improvement at the Edmonton plant is the use of thermo-siphon reboilers. Normal practice has been to use kettle-type reboilers—small tanks with tube bundles inserted in one end for heating the liquid flowing from the base of the tower. In the kettle-type reboiler the liquid from the base of the tower flows around the outside of the steam-heated tubes and only the vapor required to supply the demands of the tower leaves the reboiler and flows back into the tower.

The thermo-siphon reboiler, Celanese-style, has tubes either 5 ft. or 6¾ ft. long. Three or four tubes can be cut from a standard 20-ft. length of tubing. The steam flows around the outside of the tubes while liquid enters the vertical tubes from the bottom and flows up through the tube. As the liquid flows up the tube, a portion of it vaporizes, lowering the density of the liquid inside the tube to such a point that an extremely high velocity results with the corresponding increase in heat transfer coefficient.

One operating reboiler of this type operates with an overall heat transfer coefficient of 800 Btu. per hr. per sq. ft. per deg. F. Except for high vacuum service the company normally uses an over-all heat transfer coefficient of 500 for design purposes with a maximum heat flux of 50,000 Btu. per hr. per sq. ft.

To date they have installed about ten thermo-siphon reboilers at the Bishop plant and they've all been too big. Since the design method is not very scientific, they've installed a pilot unit. Now engineers are getting data on a variety of products which will permit them to design these reboilers on a sounder basis. However, present basis is sound enough for their installation since the square feet required per bundle is only about half of that which would be required in the conventional kettle-type reboiler.

In the sizing of the thermo-siphon reboilers they have selected about five or six standard sizes. These are constructed so that either the tube bundle alone or the entire unit is completely interchangeable with most of the other units of similar size in the plant. They will be able to stock spare reboilers which will fit in many places.

The short lengths of tubes used in this type of reboiler mean that they do not need expansion joints or floating tube sheets to take care of thermal expansion. As a matter of fact there are no floating tube sheets in any of their heat exchangers. Unequal expansion of the bolts and floating head flanges can result in minute leaks which would contaminate products, most of which have impurities limited to a few part per million.

### STANDARDIZATION

Another feature of the Edmonton plant is the standardization of pumps. Excluding special pumps for extremely large quantities or extremely high heads, there are very few different pumps within the plant. For example in the cast iron and steel pumps there are no more than six different sizes. Most parts of these are completely interchangeable with each other.

While some efficiency is sacrificed by this method of pump selection, investment for spare parts and warehouse space is kept at a minimum. Further, by the purchase of large numbers of pumps of exactly the same description, a considerable price advantage is obtained from the manufacturer. Each pump installed will be mounted so that the largest size motor demanded by that pump under any conditions can be installed.

Standardization of the instrumentation of the plant is being carried out as far as possible. Instruments are being purchased on blanket order in the same manner as valves, pipe fittings, etc. Thus any instrument received will be suitable for installation any place in the plant and will not receive a tag number or name until it is actually installed.

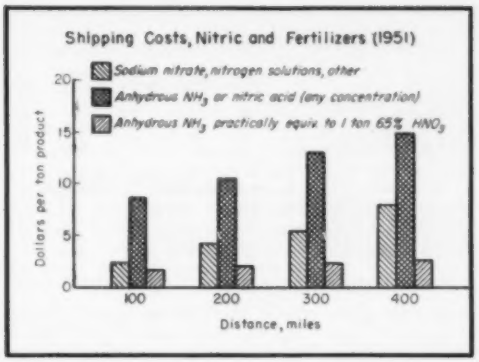
### AIR-COOLED EXCHANGERS

At it's new Pampa, Tex., plant, Celanese is flouting the general view that air is a poor cooling medium. Air-finned coolers will supply about 79 percent of the cooling load there.

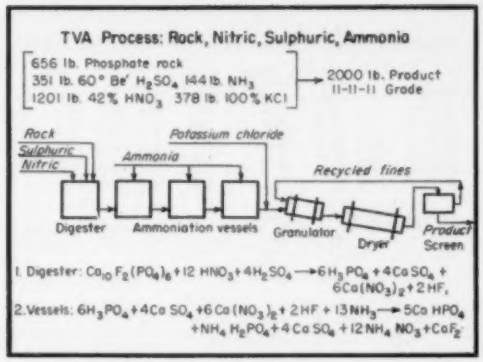
Upon examination of finned tubes and finned tube installations available today, company engineers found that air cooling is competitive with water cooling if the cooling temperature is about 80 deg. above the ambient air temperature. Even in areas where water is plentiful, it is becoming increasingly desirable to use air cooling for the higher temperature services to increase the run length of the equipment. Extended run lengths with cooling water equipment can be achieved only if expensive treatment of the water is provided.

An indication of the cost of cooling water treating is that more money is spent for chemically treating one gallon of cooling tower makeup at the Celanese plant at Bishop than is spent for chemical treatment of one gallon of boiler makeup water. Exchangers in the plant which were formerly scaled at the end of 90 days do not now require cleaning at the end of one year's operation. If scaled exchangers are the only reason for a down time, then one can easily say that the cooling water treatment is justified.

On the other hand, if one can install an air cooler in place of a water cooler, with the same horse power requirements as the cooling tower fans and pumps, and eliminate the chemical treating cost, then the move should certainly be made. In the operation of finned tube air coolers, coefficients between 80 and 100 Btu. per hr. per sq. ft. per deg. F. based on the internal area of the tube are not uncommon. This high coefficient is due to the high ratio of external finned surface to internal surface.




COST of shipping is a limiting factor in nitric's future.




TECHNOLOGY of new processes is an expanding factor.

# What's Ahead for Nitric Acid

**The author explores the technology and economics of nitric acid in the fertilizer industry with the accent on the future. Special attention is given to comparison of the processes for the nitric acidulation of phosphate rock.**

E. D. CRITTENDEN

The great triumvirate of acids in fertilizer technology is composed of sulphuric, phosphoric and nitric acids. The first two are used principally to treat phosphate rock rendering the $P_2O_5$ more available for plant growth than in the rock itself. On the other hand, nitric acid plays its part in fertilizer technology almost entirely through production of nitrate salts and, up to now, has been used only to a minor extent for treating phosphate rock. What the future holds for the acid, both for the production of its salts and in direct acidulation of phosphate rock, will be explored in this article.

Nitric acid, through its salts, constitutes one of the prime sources of crop-growing nitrogen in the United States and throughout the world.

In recent years the consumption of commercial nitrogen fertilizers in the United States has reached and exceeded one million net tons N. About 85 percent of the nitrogen is derived from the primary product ammonia and about 85 percent of the nitrogen is applied to the ground in the form of ammonium nitrate, ammonium sulphate, sodium nitrate and ammonium phosphates.

E. D. CRITTENDEN is Director of Development, Solvay Process Div., Nitrogen Section, Allied Chemical & Dye Corp., Hopewell, Va. The above article is based on a paper presented to the Soil Science Society of America at Pennsylvania State College, Aug. 27, 1951.

## 1. THE PRESENT NITRIC PICTURE

Nitric acid has a variety of direct industrial uses, but the total tonnage consumed in this manner is relatively small. Up to the present, no nitric acid is employed for direct agricultural use and in this country only a limited quantity is used in fertilizer technology —and this is on an experimental basis. By far the largest use is in making nitrates for agricultural and industrial outlets.

The principal nitrates which are used industrially are ammonium nitrate and sodium nitrate, although a number of others such as potassium, calcium, barium, strontium and zinc nitrates find limited outlets. In agriculture, ammonium nitrate and sodium nitrate account for nearly 98 percent of all nitrates consumed recently in the United States.

## 2. WHAT IS NITRIC'S POTENTIAL?

There are four major possibilities foreseen for the greater use of nitric acid in fertilizer technology:

1. Continued expansion in ammonium nitrate products, both solids and liquids.

2. Ultimate production of potassium nitrate in limited quantities in the United States for fertilizer use.

3. Expansion of calcium nitrate production abroad and some possibility of limited domestic production.

4. Growth in nitric acid processing of phosphate rock throughout the world. In the United States the extent to which this will develop depends on the long range sulphur supply situation and a number of economic factors in the domestic plant food nitrogen picture.

Ammonium nitrate is a firmly established source of nitrogen in world agriculture and is a convenient and economic means for converting synthetic ammonia to a highly useful agronomic material. The expected expansion in ammonium nitrate will occur both in solid products and in ammoniating solutions since evidence is accumulating that higher rates of ammoniation per unit $P_2O_5$ are feasible. This will mean that even with less sulphuric acid available to produce superphosphates, the higher permissible ammoniation rates will allow expansion in total ammoniating solutions, the principal ones of which are the ammonium nitrate-$NH_3$ types.

Potassium nitrate has a favorable agronomic rating and would furnish both nitrogen and potash. The market for potash without chloride has been growing, but has been supplied so far by potassium sulphate and potassium magnesium sulphate. With the in-

**Typical Products From Phosphate Rock With Nitric***

| Grade | N | $P_2O_5$ Total | $P_2O_5$ Available | $H_2O$-Sol. | $K_2O$ | $SO_3$ | CaO | $H_2O$ |
|---|---|---|---|---|---|---|---|---|
| 8-17-0 | 8.2 | 16.9 | 16.6 | 6.5 | 0.0 | 22.6 | 24.0 | 1.8 |
| 14-14-0 | 14.5 | 14.2 | 14.1 | 1.1 | 0.0 | 13.0 | 20.1 | 0.7 |
| 17-22-0 | 17.5 | 22.2 | 21.9 | 1.6 | 0.0 | 0.0 | 17.1 | 1.8 |
| 12-35-0 | 12.1 | 35.6 | 35.4 | 16.5 | 0.0 | 0.0 | 16.7 | 0.7 |
| 11-11-11 | 11.7 | 11.9 | 11.4 | 1.7 | 11.2 | 11.2 | 16.9 | 0.7 |
| 15-15-10 | 14.9 | 15.3 | 15.0 | 0.0 | 9.7 | 0.0 | 11.3 | 2.9 |
| 16-16-14 | 14.4 | 14.6 | 14.4 | 1.6 | 14.3 | 0.0 | 11.3 | 2.9 |

* Compositions in weight percent.
Source: Walthall, J. H., 1950. Chemistry and Technology of New Phosphate Materials. Short Course in Fertilizer Technology. Soil Science Society of America. University of Maryland.

**Material Quantities for Phosphate Processes**

| | Moles per mole Fluorapatite $NH_3$ | $HNO_3$ | $H_2SO_4$ | $H_3PO_4$ | $H^+$ |
|---|---|---|---|---|---|
| Ammoniated Superphosphate | 8 | 0 | 7 | 0 | 14 |
| Ammoniated Triple Super | 11 | 0 | 0 | 14 | 42 |
| TVA Phosphate Rock-$HNO_3$ | 8 | 14 | 0 | 0 | 14 |
| TVA Rock-$HNO_3$-$H_3PO_4$ | 17 | 16 | 0 | 4 | 28 |
| TVA Rock-$HNO_3$-$H_2SO_4$ | 13 | 12 | 4 | 0 | 20 |

| | Lb. $NH_3$ per Unit $P_2O_5$ In Rock | Total $P_2O_5$ |
|---|---|---|
| Ammoniated Superphosphate | 6.4 | 6.4 |
| Ammoniated Triple Super | 8.8 | 2.6 |
| TVA Phosphate Rock-$HNO_3$ | 6.4 | 6.4 |
| TVA Rock-$HNO_3$-$H_3PO_4$ | 13.5 | 8.1 |
| TVA Rock-$HNO_3$-$H_2SO_4$ | 10.4 | 10.4 |

creasing shortage of sulphuric acid, it may be that the potassium sulphate supply will be reduced and there is a reasonable possibility that some potassium nitrate may be produced domestically.

With regard to calcium nitrate, production will continue and may expand in Europe, particularly as a coproduct with phosphate material from treatment of phosphate rock with nitric acid as practiced in the French process described by Quanquin.[3] In the United States, large scale production of calcium nitrate will depend on building up an agronomic demand for this material based on reasons which specifically favor calcium nitrate over other nitrate nitrogen carriers.

Of the really large-scale potential uses for nitric acid, the course of development in processing phosphate rock with this acid is the most difficult to predict with accuracy. Considerable pressure in this direction is being caused by the acute short supply situation of sulphuric acid for producing ordinary superphosphate and phosphoric acid. Many factors enter into this picture, not all of which are favorable, and much study will be required to properly weigh and evaluate these factors. At first sight the answer seems so simple, just replace sulphuric acid with nitric acid. However, the fact of the matter is that practically the whole technology of superphosphate manufacture will need to be altered to accommodate the use of nitric acid. This applies to equipment, to processing method, to product finishing steps, and likewise to acceptance of the products.

### 3. Here's What Will Affect Nitric's Future

The idea of using nitric acid for treating phosphate rock is by no means new. The Germans were operating a process in the late 1920's by which they produced one or more of the Nitrophoskas. Dorr-Liljenroth offered processes and plants in the middle 1930's based on extensive development work both of the laboratory and pilot plant type. To date no nitro-phosphate process has developed on a really large scale in this country although ammonation of superphosphates, practically unknown before 1930, has become a major development. Plants producing nitro-phosphates are in operation in Europe, and Tennessee Valley Authority has done extensive pilot plant work on processes and on agronomic testing of the products. Walthall[2] has given an excellent summary of nitric acid-phosphate rock processes and includes many references to developments outside this country.

In Table I, a summary is given of the material quantities which are typical of superphosphate processes and of three nitro-phosphate processes. The ammoniation rates in the superphosphate processes have been taken as the same as given by Walthall in the three processes designated in the table as TVA. With regard to moles $H^+$ per mole fluorapatite it will be noted that the processes using sulphuric acid and nitric acid separately employ 14 moles $H^+$ in each, while in the case of the mixed nitric-sulphuric acid process 20 moles $H^+$ are employed, i.e., a fairly high degree of overacidulation. Walthall comments that the process using $HNO_3$ alone does not give a suitable product. No ready means, apparently, has been found to make this process successful even with high ammoniation rates due to tendency for product to liberate free acid on storage.

The most successful processes studied by TVA are those using nitric acid in admixture with either sulphuric or phosphoric acid. The figure (p. 177) outlines such a process as to steps and quantities of materials involved. The product, after granulation and drying, is said to have good storage properties and to have given excellent results in crop-growing tests. The N-P products can be made or potash may be added in one of the last steps to give a complete N-P-K fertilizer. A summary of products prepared by TVA is given in the table above.

Successful processes utilizing phosphate rock and nitric acid are said to be in operation in France, Belgium and The Netherlands. The British are reported to have a process in pilot plant stage. An examination of the many processes which have been described and patented shows that all of them have two major steps in common, namely:

1. Digestion of phosphate rock with nitric acid of 40 to 60 percent concentration. The rock is usually ground, but in one process lump phosphate rock is utilized. Calcination of the rock before digestion is mentioned in some processes and may be advantageous if much carbonate or organic matter is present in the rock in order to reduce the loss of nitric acid through an unwanted side reaction or from evolution of nitrogen oxides coming by reduction of $HNO_3$.

2. Heavy ammoniation of the digested rock product at some stage ahead of finishing, which is usually by granulation and thorough drying.

The basic reactions, using nitric and sulphuric acids, have been presented.[6]

One of the problems of these processes is that calcium nitrate is present in the reacted mass of phosphate rock and $HNO_3$ even when mixed acids are employed. In the successful processes using nitric acid, this calcium nitrate is completely eliminated. Various means for accomplishing this elimination are used or have been proposed. The more important involve:

1. Complete solution of the phosphate rock in nitric acid and removal of a large part of the calcium nitrate by partial crystallization before ammoniation. This calcium nitrate may be finished to a saleable product or converted by ammoniation with $NH_3$ plus $CO_2$ to a mixture of ammonium nitrate and calcium carbonate (similar to ammonium nitrate-limestone mixtures). The mixture, after partial removal of calcium nitrate, is then ammoniated and finished to an N-P product.

2. When mixed acids are used to digest phosphate rock, complete elimination of the calcium nitrate by heavy ammoniation.

3. Handling calcium nitrate prob-

lem by adding ammonium sulphate after rock digestion and ahead of ammoniation; a procedure under study by I.C.I. It may also be handled by adding potassium sulphate after digestion, in which case complete N-P-K fertilizers are produced.

Components common to all products made via nitric acid treatment of phosphate rock are: dicalcium phosphate, ammonium nitrate, and calcium fluoride. Other components which may be present, depending on the process, include: calcium sulphate, ammonium (mono) phosphate, potassium chloride, potassium nitrate, and calcium carbonate. While not mentioned in the literature, it seems likely that tricalcium phosphate can form, which in turn may lead to hydroxyapatite and fluorapatite as in the case of ammoniated superphosphates. Since the nitric acid-phosphate rock processes which are successful include a thorough drying in the finishing steps, unwanted reversion of $P_2O_5$ is less likely to occur than in highly ammoniated superphosphates, but the same potentiality is there. As in usual superphosphate processes, the other minor components of phosphate rock like iron, aluminum, magnesium and sodium are present in the final products of the nitric acid-phosphate rock processes.

Comparing the conditions in the nitric acid-phosphate rock processes with those existing in ordinary and triple superphosphate manufacture shows that in the digestion step, and at least in the early stages of ammoniation, expensive corrosion resisting equipment must be used. Provision may possibly be required to recover nitrogen oxides evolved in the digestion step. More extensive equipment is projected for finishing the nitrophosphate products than is ordinarily employed today in producing ammoniated superphosphates or ammoniated complete fertilizers. As ammoniation rates increase, however, some of this difference will be eliminated.

Some broad economic facts regarding nitric acid must be brought into the picture to arrive at a sound understanding of the present status and possible future course of nitric acid-phosphate rock processes. Today in the United States, the bulk of the nitric acid is produced and utilized at plant locations where synthetic ammonia is made. An appreciable quantity of ammonia is shipped to separate plants where it is converted to nitric acid for sale into industrial outlets or for conversion into products going to industrial uses.

Put another way, nitrate nitrogen for agriculture in this country is produced almost entirely at the large synthetic nitrogen fixation plants. At first sight, it appears that phosphate rock might be brought to the source of nitric acid for processing. Fundamentally, the idea is sound and developments along this line may be forthcoming. However, it's pertinent to note that going into nitro-phosphate manufacture at present would entail diversion of nitric acid away from ammonium nitrate and sodium nitrate, demands for which exceed the supply.

There is evidence that several nitrogen producers besides TVA are looking into the possibility of utilizing nitric acid for treating phosphate rock, but no production plans have been announced.

Two other cases are worth considering, namely:

1. Shipping nitric acid from the major nitrogen plants to the fertilizer plants.

2. Shipping anhydrous ammonia to fertilizer plants where it would be converted to nitric acid and used by the phosphate manufacturers to treat phosphate rock.

Major factors in the first case are the price which could be obtained for nitric acid and the cost of shipping nitric acid from producing to consuming points. A comparison of approximate shipping costs for fertilizer materials, anhydrous ammonia and nitric acid is given (see cut). It will be noted that at short distances, it costs about four times as much per ton mile to ship nitric acid and anhydrous ammonia as to ship sodium nitrate and nitrogen solutions. At greater distances the ratio drops to about two. These figures are per ton product and, hence, do not reflect the cost per ton nitrogen or the effect of concentration in the case of nitric acid.

Under present freight classifications and rates, it is evident that shipping nitric acid as 65 percent $HNO_3$ even 100 mi. from point of manufacture is probably prohibitive (per ton N). Higher manufacturing costs for the 100 percent grade of $HNO_3$ would about cancel the reduction in freight cost per ton N. There is the possibility that lower rates comparable with fertilizer products might be obtained ultimately for agricultural nitric acid, but they are not in existence today. Assuming rates similar to those for sodium nitrate per ton, the cost of shipping per ton N for 65 percent $HNO_3$ would still be higher than those for sodium nitrate since the N content is only about 90 percent as much.

The other possibility which involves shipping anhydrous ammonia to fertilizer plants for conversion of $HNO_3$ is of some interest. In this case a plant for oxidizing $NH_3$ and converting the nitrogen oxides to $HNO_3$ would be required. Capital costs for this plant are high since special corrosion resisting equipment is required. For this case, the cost for shipping the practical quantity of anhydrous ammonia required to make one ton of 65 percent $HNO_3$ would be only about 20 percent that of the equivalent $HNO_3$.

Nitric acid is both a source of $H^+$ and of nitrogen for plant food. In the table below, a summary is given of the relative value of $HNO_3$ and $H_2SO_4$.

**Relative Value of Nitric Acid and Sulphuric Acid to Superphosphate Manufacturer**

Basic assumptions:

1. One ton $H^+$ from $HNO_3$ replaces one ton $H^+$ from $H_2SO_4$.

2. 96.5 tons 65 percent $HNO_3$ is equivalent to 49 tons 100 percent $H_2SO_4$.

3. Nitrogen recovered for credit from $HNO_3$ equals 13.5 tons.

4. $P_2O_5$ is recovered in same quality and yield as in usual superphosphate manufacture.

Unit values:

| | |
|---|---|
| One ton 100 percent $H_2SO_4$ is worth | $21 |
| Nitrogen credit is per net ton N | $200 |
| Net worth of 96.5 tons 65 percent $HNO_3$ at fertilizer plant: | |
| 49 tons $H_2SO_4$ at $21 | $1,029 |
| 13.5 tons N at $200 | 2,700 |
| Total | $3,729 |
| Or per net ton 65 percent $HNO_3$ | $38.70 |

Value is delivered price if $HNO_3$ were shipped to fertilizer producer.

Under the assumptions used, it will be noted that 65 percent $HNO_3$ for replacing sulphuric acid is worth about $39 per ton. This value will vary, of course, depending on the assumed value for sulphuric acid and the credit value for the N. The figures used are believed to represent a reasonably fair basis under present conditions.

Elements which will play a part in the future of nitric acid in producing fertilizer phosphate products are clearly evident although the long range balance between them is far less clear. Any seeming reluctance on the part of the nitrogen producers to make phosphate products or to sell nitric acid to fertilizer manufacturers stems not from unwillingness to serve the best interests of agriculture, but rather from practical and economic factors, both short and long range.

(*Continued* on page 286)

# How to Predict Calibration of Variable-Area Flow Meters

**Data are now available enabling anyone to size and predict accurately the calibration of variable-area flow meters (rotameters). The data can be extended also to determine the effect of meter changes on capacity and calibration.**

KERMIT FISCHER

Before the development of precision methods for forming tapered glass and steel tubes whose dimensions could be held within close tolerances, it was necessary to calibrate each variable-area flow meter or rotameter separately to incorporate its individual characteristics into the meter data. Interchangeable, precision-formed metering tubes and standardization to a few geometrically similar float shapes have now made it possible to predict the calibration for flow meters of this type.

Standard float shapes were selected by experiment so that flow through the meter can be represented by one basic flow curve, valid for all meter sizes and float dimensions. The practically linear basic flow curve (solid curve in Fig. 1) plots the height of the float above a reference mark on the tube vs. the flow through the meter, expressed as a percentage of the capacity of the meter (i.e., percent of maximum flow). It represents the average performance of predictable floats and metering tubes. Meter calibration can be predicted with a probable deviation of 1½ percent of the maximum flow, by use of this basic flow curve.

Calibration can be predicted even more accurately by using prediction curves that take into account different float shapes and the actual fluid viscosity. These curves are similar to Fig. 4, which was determined for the most commonly used float shape. Other float shapes give somewhat different results, but prediction curves have also been determined for them. These calibration curves make it possible to solve a special form of the familiar flow meter equation and the calibration thus predicted has a standard deviation of about 1 percent of the maximum flow.

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The purpose of this article is to describe the predictable tubes and floats, to derive the calibration equations, and to outline the method for sizing area flow meters and predicting their calibration. (Data in greater detail to cover all sizes and types of such meters are contained in a variable-area meter handbook obtainable from the author's company.—*Editor.*)

### METERING TUBES

The three general types of predictable tapered metering tubes are plain tapered metal, plain tapered glass, and beaded glass with three raised bead guides on its inner surface to assure float stability without external guiding arrangements. Metal metering tubes are used for metering high pressure flows, hot or strong alkalies, fluorine, hydrofluoric acid, and steam. These require float extensions to transmit float positions to a receiving device. Glass metering tubes can be read directly or can be equipped with any of the float extensions.

Tubes with a 5-in. scale length are the recommended standard for industrial variable-area flow meters. A standard scale length allows interchangeability of metering tubes and reduces the plant inventory of replacement parts. Seven sizes of predictable meters measure flows in lines from ¼ to 4 in. in diameter, and work is now being done to extend this range. Glass tube variable-area meters, comprising a float inside the tapered tube, are usually inclosed in a metal case with a glass window. Area meters can be either screwed or flange-fitted in an upright position into the piping system carrying the fluid to be metered.

The float height above a reference mark on the tapered tube is a linear function of the ratio of tube diameter to float diameter $D_t/D_f$. A straight-line graph of $D_t/D_f$ vs. float height cannot be read accurately enough for use in calibration prediction, so tables of this relationship have been prepared for all tubes. The maximum value of $D_t/D_f$ is taken as the measure of tube taper because of the frequent use of this quantity in meter calibra-

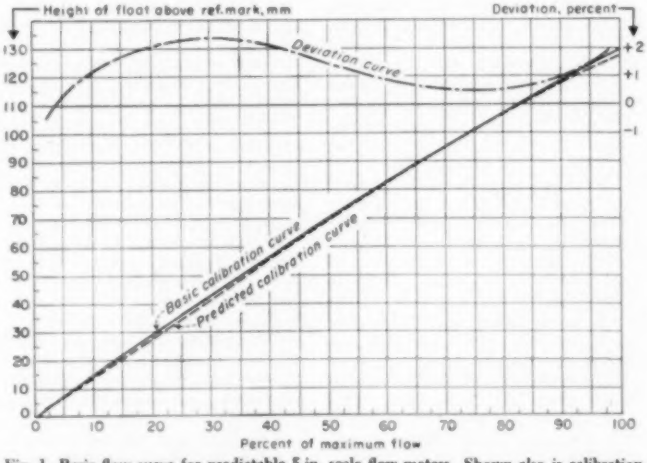



**Fig. 1—Basic flow curve for predictable 5-in. scale flow meters. Shown also is calibration curve calculated for a sulphuric acid meter, and curve for deviation of this predicted calibration from the basic curve.**

tion. Most tubes have a single taper, but meters, especially the larger ones, sometimes employ tubes with two or three tapers, carefully chosen so that the regular meter data are valid for these tubes. The float height in millimeters for the various values of $D_t/D_f$ for a beaded glass tube of taper 1.27 and $D_f = 1.004$ in. is shown in Table I. Similar tables have been prepared for all other tube sizes and types.

### FLOAT SHAPES

Float standardization to the shapes shown in Fig. 2 permits mathematical conversion from one meter size to another and forms the basis of a continuous capacity range for predictable floats. Float shape *a* is used primarily where light float weight is required, as with very low pressure drop meters.

Float type *b* offers the advantage of permitting a significant change in viscosity with little or no change in flow coefficient. A meter capacity increase can be obtained by reversing the head of float shape *b* and converting it to type *c*. Type *c* provides a streamlined shape for the fluid entering the annular orifice and is used to best advantage in regions of low viscosity. These floats can be head-guided in a beaded tube, with an extension providing the second guide contact, or can be center guided in plain taper metering tubes.

Shapes *d* and *e* are similar to *b* and *c* except that they require tail guides to assure stability. They are used in meters employing beaded glass tubes for visual indication. The addition of tail guides changes the flow coefficients enough to require separate prediction curves. Point scatter caused by the tail guides makes these shapes slightly less predictable than *b* and *c*.

Float dimensions are very critical to the performance of the meter. The most important of these dimensions is the metering edge which is $0.01D_f$ to a tolerance of the order of $\pm 0.001$ in. The diameter of the body of the meter is specified to tolerances of $\pm 0.001$ in. for all float sizes and is given by $0.62D_f$ only to two decimal places. Because of the importance of dimensional stability, predictable floats cannot be made from plastics, ceramics, or soft metals. Most common float materials are stainless steel, Hastelloy, Monel, nickel, brass and bronze.

Floats are kept centered in the tube by a guide wire, by raised beads on the inner surface of the tube, or by extensions attached to the float. Extensions include magnetic coupling, mercury switch or inductance alarm, dashpot or weight housing, and electric or electronic remote transmitting. The first type can also be used with a pneumatic transmitter. These various extensions influence meter calibration by increasing the weight of the float. Hence their dimensions are specified and controlled in manufacturing. Float weight influences meter calibration as the square root and is therefore not as critical as the float diameter $D_f$.

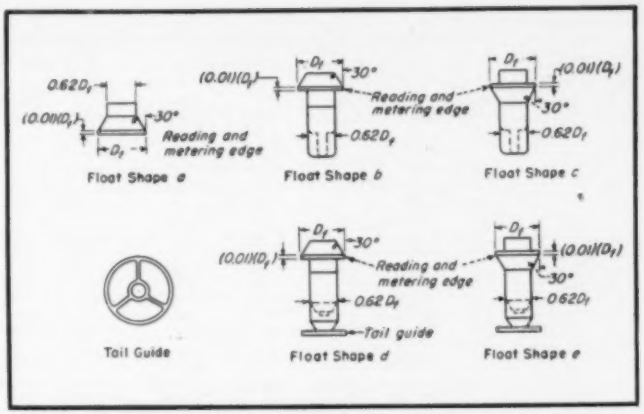



**Fig. 2—Geometrically similar float shapes permit same calibration data to be used for any size meter. Only four types are needed to cover the range.**

### NOMENCLATURE

- $D_f$ Diameter of float, in.
- $D_t$ Diameter of tube; or scale reading, in.
- $F$ Net buoyed float weight, force.
- $g$ Acceleration of gravity, ft./sec.²
- I.C. Instrument constant $= D_f\ (F\ \rho_w)^{\frac{1}{2}}$, lb./min.
- $K$ Simplified flow coefficient, dimensionless.
- $N$ Viscous influence number, dimensionless.
- $P_{std}$ Pressure at base condition, psia.
- $Q$ Maximum flow rate of meter expressed as gpm. water equivalent.
- $T_{std}$ Temperature of base condition, 460 + $T$ deg. F., abs. temp.
- $v_f$ Volume of float, cu. in.
- $W$ Mass rate of flow, mass/sec.
- $w_f$ Weight of float, grams.
- $\mu$ Dynamic viscosity, centipoises.
- $\rho_f$ Density of float material, gm./cc.
- $\rho_s$ Density of gas at STP, lb./cu. ft.
- $\rho_g$ Density of gas at operating conditions, lb./cu. ft.
- $\rho_w$ Density of metered fluid, gm./cc.

**Table I—Correlation of Tube-Float Diameter Ratio With Float Height**

(Beaded glass tube of $(D_t/D_f)_{max.} = 1.27$; float diam. = 1.004 in.)

| $D_t/D_f$ Ref. | Height Above Mark, Mm. | $D_t/D_f$ Ref. | Height Above Mark, Mm. |
|---|---|---|---|
| 1.25 | 120.5 | 1.07 | 20.7 |
| 1.20 | 95.1 | 1.06 | 26.2 |
| 1.18 | 85.1 | 1.05 | 21.7 |
| 1.16 | 75.1 | 1.04 | 17.3 |
| 1.14 | 64.8 | 1.03 | 12.9 |
| 1.12 | 54.7 | 1.02 | 8.5 |
| 1.10 | 44.8 | 1.01 | 4.2 |
| 1.08 | 35.3 | | |

**Table II—Variables Used in Calibration Relations**

| Variable | Symbol | *MLT* Dimensions | New System Dimensions |
|---|---|---|---|
| Scale reading | $D_t$ | $L$ | $D_f$ |
| Float diameter | $D_f$ | $L$ | Fundamental |
| Net buoyed float weight | $F$ | $MLT^{-2}$ | Fundamental |
| Fluid density | $\rho_w$ | $ML^{-3}$ | Fundamental |
| Mass rate of flow | $W$ | $MT^{-1}$ | $D_f\sqrt{F\rho_w}$ |
| Fluid dynamic viscosity | $\mu$ | $ML^{-1}T^{-1}$ | $\sqrt{F\rho_w}$ |

### CALIBRATION RELATIONS

The easiest way to derive the relations needed for calibration prediction is by a dimensional analysis of the flow through the meter. For the analysis we will use a convenient system of units to replace the conventional mass, length, and time (*MLT*) coordinates. The new fundamental units are: $F$ = net buoyed float weight, $\rho_w$ = fluid density, and $D_f$ = float diameter. Instead of taking float height as the scale reading, the more convenient tube diameter can be used because the two are related by the geometery of the metering elements. Table II shows the dimensions of the flow variables in the special system.

All of the dimension changes indicated in Table II follow directly from the definition of the new system of units except for mass rate of flow W, and viscosity $\mu$. W expressed in units of $F$, $D_f$, and $\rho_w$ is given by:

$$W = F^a\ D_f{}^b\ \rho_w{}^c \qquad (1)$$

where $a$, $b$, and $c$ are to be determined. Replacing the members in this equation by their *MLT* equivalents from Table II it becomes

$$MT^{-1} = (MLT^{-2})^a(L)^b(ML^{-3})^c$$

Equating exponents to make this equation true gives:

for $M$, $1 = a + c$
for $L$, $-0 = a + b - 3c$
for $T$, $-1 = -2a$

**Table III—Capacity Ranges and Float Weight Ranges for 5-In. Scale Length Beaded Glass Tube Meters**

(Capacities as spans in equivalent water capacities; float weights as applicable spans for stainless steel floats)

| Meter for Line Size, In. | Tube Taper, $(D_t/D_f)_{max.}$ | Float Shape | *A* Extension* Gpm. $H_2O$ | *A* Extension* Float Wt., Gm. | *B* Extension* Gpm. $H_2O$ | *B* Extension* Float Wt., Gm. | *C* Extension* Gpm. $H_2O$ | *C* Extension* Float Wt., Gm. | *D* Extension* Gpm. $H_2O$ | *D* Extension* Float Wt., Gm. | Wt. Addition† Wt. Extension, Gm. | Wt. Addition† Dashpot Extension, Gm. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/2 | 1.21 | b | 2.47–3.20 | 111 | 2.27–2.38 | 93 | 1.66–1.78 | 80 | 3.00–3.18 | 173 | —— | —— |
| 1/2 | 1.27 | b | 3.36–4.35 | to | 3.08–3.23 | to | 2.25–2.42 | to | 4.18–4.30 | to | —— | —— |
| | | c | 4.60–5.95 | 186 | 4.21–4.44 | 103 | 3.09–3.33 | 86 | 5.75–5.90 | 182 | —— | —— |
| 3/4 | 1.21 | b | 4.77–5.89 | 170 | 4.30–4.73 | 152 | 3.58–4.19 | 96 | 5.45–5.86 | 222 | 56 | 56 |
| 3/4 | 1.27 | b | 6.83–8.44 | to | 6.45–6.79 | to | 5.13–6.00 | to | 7.80–8.42 | to | to | to |
| | | c | 9.44–11.6 | 260 | 8.91–9.36 | 168 | 7.09–8.36 | 132 | 10.8–11.6 | 259 | 70 | 165 |
| 1 | 1.27 | b | 9.15–11.8 | 210 to | 8.83–10.2 | 195 to | 7.55–9.41 | 143 to | 10.4–11.8 | 271 to | 99 to | 99 to |
| | | c | 12.6–16.2 | 351 | 12.2–14.2 | 267 | 10.4–12.9 | 222 | 14.3–16.3 | 352 | 121 | 240 |
| 1 1/2 | 1.22 | b | 16.6–19.8 | 504 | 15.5–18.5 | 442 | 14.7–18.0 | 395 | 16.8–19.9 | 516 | 139 | 139 |
| 1 1/2 | 1.27 | b | 21.4–25.1 | to | 20.1–24.0 | to | 19.0–23.2 | to | 21.7–25.8 | to | to | to |
| | | c | 29.6–35.5 | 737 | 27.8–33.1 | 633 | 26.2–32.1 | 506 | 30.0–35.6 | 732 | 272 | 657 |
| 2 | 1.27 | b | 38.6–48.9 | 882 to | 37.1–47.1 | 814 to | 35.9–46.4 | 762 to | 39.0–49.0 | 901 to | 317 to | 317 to |
| | | c | 53.3–67.5 | 1,419 | 51.2–65.0 | 1,321 | 49.6–64.1 | 1,282 | 54.0–67.9 | 1,433 | 526 | 1,135 |
| 3 | 1.20 | b | 63.5–81.0 | 2,211 to | 62.3–80.0 | 2,125 to | 61.3–79.7 | 2,064 to | 62.8–81.5 | 2,157 to | 746 to | 746 to |
| | | c | 86.2–110 | 3,628 | 84.6–109 | 3,519 | 83.5–108 | 3,503 | 85.5–111 | 3,670 | 1,248 | 2,718 |
| 4 | 1.20 | b | 117 –136 | 4,575 to | 116 –134 | 4,491 to | 115 –134 | 4,429 to | 117 –136 | 4,586 to | 1,041 to | 1,041 to |
| | | c | 159 –185 | 6,353 | 158 –183 | 6,144 | 153 –182 | 5,994 | 159 –186 | 6,295 | 2,198 | 4,618 |

* Extensions are attachments to float which enable float position to be detected outside metering tube: *A* extension is a magnetic coupling extension with close-coupled secondaries or pneumatic transmitter; *B* extension is a magnetic or glass tube opaque indicator or mercury switch alarm; *C* extension is a convertible indicator, electronic transmitter or inductance alarm; *D* extension is an electrical transmitter.

† Stainless steel weight addition, in grams, involving either a weight housing or dashpot extension.

Solving these simultaneous equations gives $a=\frac{1}{2}$, $b=1$, and $c=\frac{1}{2}$ which when substituted into Eq. (1) shows the dimensions of W to be $D_f\sqrt{F\rho_w}$. Flow rates measured in the $F$-$D_f\rho_w$ system of units therefore can be written as

$$W = KD_f\sqrt{F\rho_w} \qquad (2)$$

where $K$ is a dimensionless number having a single value for each dynamic condition. This equation is the flow equation in terms of units convenient for variable-area flow meter calibration. We may define $K$ as a simplified flow coefficient, and $D_f\sqrt{F\rho_w}$ as the instrument constant, I.C. However, it will be more convenient to eliminate $F$ from this expression. In Eq. (2) $F$, the net buoyed float weight, is equal to the dry weight of the float minus the displaced weight of the fluid, or

$$F_* = g\,v_f(\rho_f - \rho_w) = \frac{w_f(\rho_f - \rho_w)}{\rho_f}$$

Eliminating $F$ from the expression the instrument constant becomes:

$$\text{I.C.} = D_f\sqrt{w_f\frac{\rho_f - \rho_w}{\rho_f}\rho_w} \qquad (3)$$

And flow rate is then:

$$W = K\,(\text{I.C.}) \qquad (4)$$

Viscosity in units of $F$, $D_f$ and $\rho_w$ can be found by the same method that was used for finding the units of W. The dimensional equation for viscosity in the special system is

$$\mu = F^a\,D_f^b\,\rho_w^c \qquad (5)$$

Replacing its members by their $MLT$ equivalents from the table gives

$$ML^{-1}T^{-1} = (MLT^{-2})^a\,(L)^b\,(ML^{-3})^c$$

By equating coefficients and solving the simultaneous equations it can be shown that $a=\frac{1}{2}$, $b=0$ and $c=\frac{1}{2}$. Substituting the values of a, $b$ and c in Eq. (5) shows that the units of viscosity are $\sqrt{F\rho_w}$ and therefore can be written

$$\mu = N\sqrt{F\rho_w} \qquad (6)$$

where $N$ is a dimensionless number. $N$, the viscous influence number, can be converted to the more familiar Reynolds number with the aid of a correlation curve, as in Fig. 3.

Substituting for $F$ and rearranging (6) shows the viscous influence number in the special units to be

$$N = \frac{\mu}{\sqrt{w_f\frac{\rho_f - \rho_w}{\rho_f}\rho_w}} \qquad (7)$$

The other variables influencing the flow conditions (such as fluid elasticity and apparent yield stress) can also be converted into $F$-$D_f\rho_w$ units.

The flow coefficient $K$ depends on the viscosity and float height. But, as was shown above, $K$ is dimensionless. Therefore, viscosity and float height must enter $K$ as dimensionless quantities. Since $N$ and $D_t/D_f$ are dimensionless measures of viscosity and float height, $K$ is a function of these quantities. Viscosities that differ radically in the conventional system can all be equal to the same $N$ value when expressed in the $D_fF$-$\rho_w$ system. All flows whose viscosities equal the same $N$ (when analogous equality holds for compressibility and yield stress) are said to be dynamically similar. For dynamically similar conditions, $K$ will always be obtained at the same scale reading $D_t/D_f$ and a single test calibration can be used.

The dependence of $K$ on $N$ and $D_t/D_f$ for one of the four standard float shapes (*b* in Fig. 2) is shown

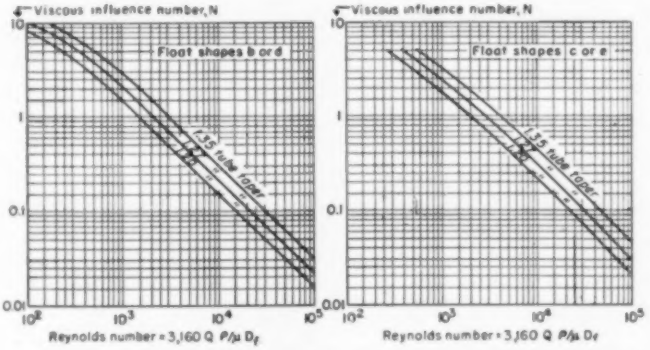



**Fig. 3—Viscous influence numbers for basic float types can be correlated with the Reynolds number, depending on tube taper. Fig. 2 identifies float types.**

in Fig. 4. The value of $K$ for given values of $D_t/D_f$ changes little over a wide range of $N$. Therefore, percent-of-maximum-flow scales printed on meters and meter capacity tables can be based on water viscosity flow coefficients and still apply over this range of $N$. The value of $N$ below which changes in $N$ do not greatly affect the value of $K$ is called the viscosity immunity ceiling. To find if a particular flow is below the viscosity immunity ceiling, one has only to compute $N$ approximately and refer to the appropriate calibration curve.

### METER SIZING

To help select meters for specified flow requirements, several capacity tables have been developed showing the capacity of meters for all combinations of meter sizes, tube types, tube tapers, float shapes, and extensions. The one applicable to beaded glass metering tubes is shown in Table III. The flow rates listed are the maximum that can be obtained with the specific components shown. A span of flow rates is given and any maximum flow rate between the values listed can be obtained by controlling the float weight. This permits integral and convenient meter factors not readily available in area meter practice before completion of the predictable meter program.

To use the capacity tables, the maximum flow to be measured must be converted to a capacity equivalent to gpm. $H_2O$, designated as $Q$, by the appropriate formula listed below:

$$Q_{(liquid)} = \frac{gpm. \times \rho_w \times 2.65}{\sqrt{(\rho_f - \rho_w)\,\rho_w}} \qquad (8)$$

$$Q_{(gas)} = \frac{SCFM \times \rho_a \times 2.51}{\sqrt{\rho_f \times \rho_a'}} \times \frac{530}{T_{std}} \times \frac{P_{std}}{14.7} \qquad (9)$$

Then locate the equivalent capacity in gpm. $H_2O$ in the appropriate capacity table (for example, Table III) under the desired extension type. This table also gives the tube taper, float shape and float weight. If a choice exists between float shapes $b$ and $c$, select $b$ because its viscosity range is greater.

Float weight within the span given by capacity tables is found by:

$$W_f = \left( \frac{Q \times 3.14 \times \sqrt{\rho_f}}{K_{max} \times D_f} \right)^3 \qquad (10)$$

where $K_{max}$ = flow coefficient at 100 percent capacity. The values of $D_f$ and $K_{max}$ are given in Table IV for the meter size selected.

All meters are calibrated in percent of maximum flow using the basic calibration curve of Fig. 1. However, slightly higher calibration accuracy can be achieved by the use of the prediction curves for the specific float used and fluid metered. Fig. 4 is typical of the four prediction curves that have been developed to take care of the four float shapes. If the more accurate calibration possible with the prediction curves is needed, the procedure consists in solving the basic flow equation, Eq. (4), at a number of points along the scale. To do so after a meter has been selected, the values of the instrument constant I.C. and the viscous influence number $N$ are calculated from data of the instrument and the fluid, using Eqs. (3) and (7). At the value of $N$ so determined values of $K$ are taken from the curves of Fig. 4 for each of several float heights (values of $D_t/D_f$). Each $K$ value multiplied by the I.C. value then gives a calibration point.

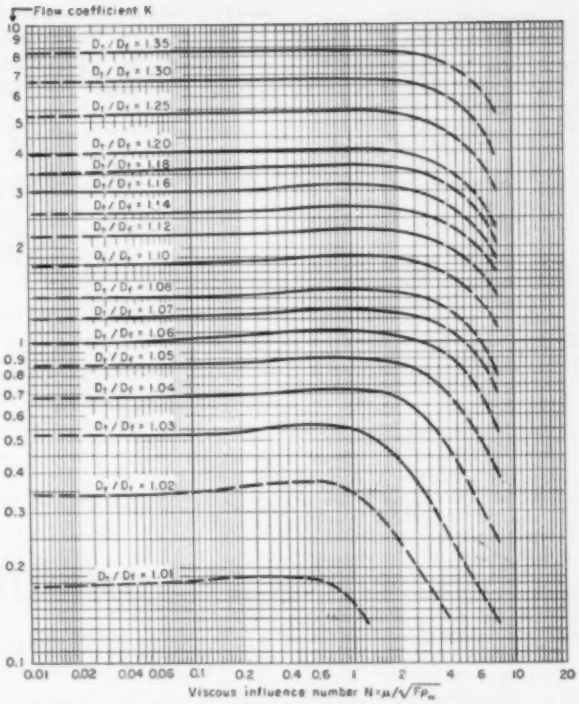



**Fig. 4—Calibration curves for float shape *b* show $K$ as a function of $N$ and $D_t/D_f$. Such curves permit more accurate calibration than basic flow curve.**

The value of I.C. as given by Eq. (3) is in terms of lb./min. For calibration it must be converted to the appropriate volume measure to be used in the calibration curve, for example, gal./min. for liquids, or std. cu. ft./min. for gases. To do so it is only necessary to divide the I.C. value obtained from Eq. (3) by the lb. of liquid per gal., or by the lb. of gas per cu. ft. at STP.

### PREDICTION DATA IN USE

*Example*—Assume we desire to size and predict the calibration of a meter to handle a normal flow of 4.0 gpm. of sulphuric acid of density 1.84 grams/cc., having a viscosity of 28 cp. We will assume the use of a meter having a beaded glass tube, engraved with a "water equivalent viscosity" percentage scale. Having predicted the calibration, we then want to prepare a deviation curve.

*Step 1*—Select a Hastelloy C float (dens. 8.94) with a magnetic coupling extension.

*Step 2*—Since the normal flow rate is to be 4 gpm., decide on a meter of maximum capacity of twice the normal, or 8 gpm.

*Step 3*—Using Eq. (8), determine the water equivalent capacity $Q$ in terms of sulphuric acid capacity and density, and the density of the Hastelloy C float:

$$Q = \frac{8.0 \times 1.84 \times 2.65}{\sqrt{(8.94 - 1.84) \times 1.84}} = 10.8$$

*Step 4*—Refer to capacity Table III and select a meter size for a water equivalent capacity of 10.8 gpm. In the column for "magnetic coupling extension" find two possible choices—either a ¾ in. meter with water flow span of 9.44 to 11.6 gpm. using a type c float; or a 1 in. meter with 9.15 to 11.8 flow span, using a type b float.

*Step 5*—Since the type b float has the higher viscosity ceiling, select the second possibility, i.e., the 1 in. meter. From Table IV, with the 1 in. meter and beaded glass tube, note that $D_f = 1.004$ in., the tube taper is 1.27, and $K_{max}$ for the b type float is 5.610. The float weight from Eq. (10) is:

$$\left(\frac{10.8 \times 3.14 \times \sqrt{8.94}}{5.610 \times 1.004}\right)^2 = 322 \text{ gram}$$

This means that a Hastelloy C float of the b type, with $D_f = 1.004$ and a weight adjusted to give a weight of 322 grams will give a scale reading of 100 percent in the size and type of meter tube selected when the flow rate of sulphuric acid is 8.0 gpm. With the meter calibrated in percent, each percentage mark on the scale will correspond to 8.0/100 or 0.08 gpm., the meter factor.

*Step 6*—The percentage markings on the meter will be in accordance with the basic calibration curve of Fig. 1. It is desirable to achieve a still closer calibration by means of Fig. 4 so that a deviation curve can be drawn for this particular application. To do this we must first calculate the instrument constant I.C. from Eq. (3), and the viscous influence number $N$ by Eq. (7).

$$\text{I.C.}_{(\text{lb./min.})} = 1.004\sqrt{\frac{322\,(8.94 - 1.84)\,1.84}{8.94}}$$

$$= 21.737 \text{ lb./min.}$$

$$\text{I.C.}_{(\text{gpm.})} = 21.737/(\text{lb./gal. } H_2SO_4)$$

$$= 21.737/(8.377 \times 1.84)$$

$$= 1.419 \text{ gpm. } H_2SO_4$$

$$N = \frac{\mu}{\sqrt{\frac{322\,(8.94 - 1.84)\,1.84}{8.94}}}$$

$$= 28/21.65 = 1.29$$

*Step 7*—Set up Table V for recording values of the flow coefficient $K$ as determined from Fig. 4 at various heights of the float in the metering tube. As noted previously (Table I) the most convenient measure of float height is the ratio $D_t/D_f$. From Fig. 4 at an $N$ value of 1.29 pick off values of $K$ for each tabulated value of $D_t/D_f$ and record in the third column of Table V.

*Step 8*—For each value of $K$ in Table V calculate gpm. flow (fourth column) by multiplying by the value of I.C. = 1.419 gpm. $H_2SO_4$. From the gpm. flow for each $K$ value, calculate the percent of full flow (8 gpm.) for tabulation in column 5.

*Step 9*—Plot on Fig. 1 (dotted curve) the percent values in column 5 vs. the heights of the float in column 2 to give the predicted calibration curve for $H_2SO_4$ in this particular meter. Table V, column 6, tabulates the data from which the basic calibration curve of Fig. 1 was plotted. In column 7 tabulate the difference at each $K$ value between the predicted percentage (column 5) and the corresponding percentage for the basic curve (column 6). These deviations are then plotted as the dot-dash deviation curve superimposed on Fig. 1.

**Table IV—Float Head Diameters and Values of $K_{max}$ at 100 Percent of Scale**

| Meter for Line Size, In. | Float Head Diam., $D_f$, In. | Metal Metering Tube | | | Beaded Glass Metering Tube | | | Plain Tapered Glass Metering Tube | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | $K_{max}$. | | | $K_{max}$. | | | $K_{max}$. | |
| | | Tube Taper* | Float b | Float c | Tube Taper | Float b | Float c | Tube Taper | Float b | Float c |
| 1/2 | 0.5060 | 1.20 | 3.776 | 5.169 | 1.21 | 4.116 | 5.643 | 1.19 | 3.697 | 5.052 |
| | | 1.36 | 5.632 | 7.716 | 1.27 | 5.388 | 7.661 | 1.27 | 5.676 | 7.815 |
| | | 1.35 | 8.432 | 11.684 | | | | 1.35 | 8.289 | 11.419 |
| 3/4 | 0.8110 | 1.20 | 5.163 | 7.083 | 1.21 | 4.034 | 5.518 | 1.27 | 5.676 | 7.815 |
| | | 1.35 | 8.289 | 11.750 | 1.27 | 5.776 | 7.969 | 1.35 | 8.289 | 11.463 |
| | | 1.35TT | 8.046 | 11.111 | | | | | | |
| 1 | 1.004 | 1.35 | 8.289 | 11.570 | 1.27 | 5.610 | 7.716 | 1.35 | 8.333 | 11.596 |
| | | 1.35TT | 8.046 | 11.111 | | | | | | |
| 1 1/2 | 1.505 | 1.27 | 5.676 | 7.848 | 1.22 | 4.365 | 5.985 | 1.27 | 5.676 | 7.848 |
| | | 1.35TT | 8.046 | 11.177 | 1.27 | 5.654 | 7.821 | 1.35 | 8.322 | 11.662 |
| 2 | 2.020 | 1.35TT | 8.046 | 11.177 | 1.27 | 5.736 | 7.925 | 1.35 | 8.421 | 11.728 |
| | | 1.24DT | 4.949 | 6.746 | 1.20 | 3.990 | 5.438 | 1.27 | 5.676 | 7.848 |
| 3 | 3.012 | 1.35TT | 8.046 | 11.177 | | | | | | |
| 4 | 4.040 | | | | 1.20 | 3.798 | 5.160 | 1.27 | 5.676 | 7.848 |

* DT refers to double-, and TT to triple-taper metering tube.

**Table V—Tabulation of Values for Typical Meter Calibration**

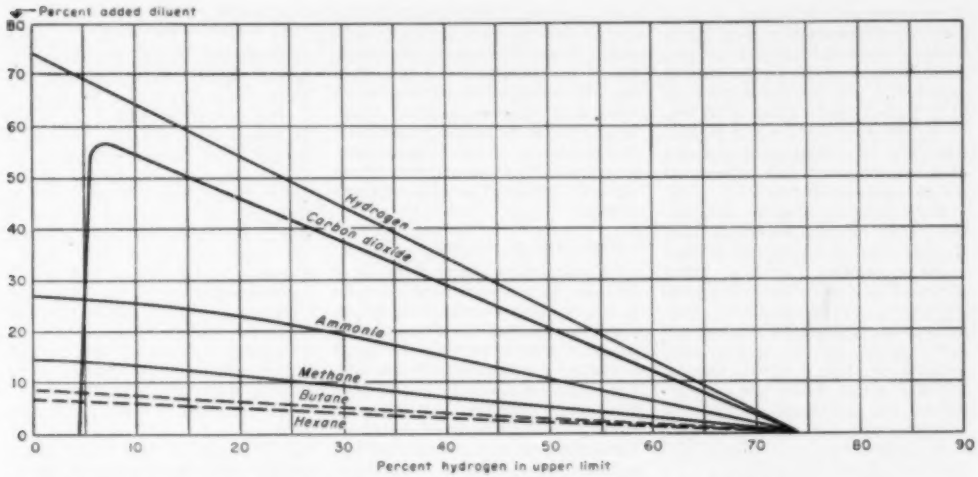
| $D_t/D_f$ | Ht. Above Tube Ref. Mark, Mm. | $K$ | Predicted Flow, Gpm. ($K \times$ I.C.) | Percent of Max. Flow (8 gpm.) | Basic Flow Curve Values (Fig. 1) | Deviations, Col. 5 − Col. 6 |
|---|---|---|---|---|---|---|
| 1.25 | 120.5 | 5.23 | 7.42 | 92.7 | 91.5 | +1.2 |
| 1.20 | 95.1 | 3.98 | 5.65 | 70.6 | 70.0 | +0.5 |
| 1.18 | 85.1 | 3.52 | 5.00 | 62.5 | 61.5 | +1.0 |
| 1.16 | 75.1 | 3.06 | 4.34 | 54.1 | 53.5 | +0.6 |
| 1.14 | 64.8 | 2.62 | 3.72 | 46.5 | 44.5 | +2.0 |
| 1.12 | 54.7 | 2.215 | 3.145 | 39.3 | 37.3 | +2.0 |
| 1.10 | 44.8 | 1.835 | 2.605 | 32.5 | 30.0 | +2.5 |
| 1.08 | 35.3 | 1.44 | 2.045 | 25.5 | 23.5 | +2.0 |
| 1.07 | 30.7 | 1.24 | 1.76 | 22.0 | 20.0 | +2.0 |
| 1.06 | 26.2 | 1.07 | 1.52 | 19.0 | 17.5 | +1.5 |
| 1.05 | 21.7 | 0.885 | 1.255 | 15.7 | 14.0 | +1.7 |
| 1.04 | 17.3 | 0.705 | 1.00 | 12.5 | 11.0 | +1.5 |
| 1.03 | 12.9 | 0.505 | 0.716 | 8.95 | 8.0 | +0.95 |
| 1.02 | 8.5 | 0.31 | 0.44 | 5.5 | 5.0 | +0.5 |
| 1.01 | 4.2 | 0.13 | 0.184 | 2.3 | 2.5 | −0.2 |

CAPACITY MODIFICATION

1. *Float Weight Modification*—To increase the meter capacity the float weight can be increased by increasing the size of the body, increasing the length of the extension, or adding a weight housing between the meter body and the extension. Meter capacity can be decreased by removing metal from the float body. In Fig. 2 the dotted lines on the float bodies show the approximate maximum limits to which metal can be removed without seriously affecting the flow coefficient. The effect of changing the weight of the float on the meter capacity can be calculated by multiplying the capacity using the original float, by the square root of the ratio of weights of the old and new floats.

2. *Metering Area Change*—Meter capacity can be increased by substituting a tube of greater taper, or reduced by using a tube of lesser taper. The capacity Table III lists tube tapers available for each meter size. Table IV shows what capacity change (in terms of $K_{max.}$) can be effected in this way for any meter size.

3. *Flow Coefficient Change*—Inverting the head of a type b or type d float will give a capacity increase of about 35 percent. However, this change should not be used to increase capacity until the effect of the change has been studied by comparing the corresponding prediction curves. The reason is that the type c and e floats have a lower viscosity immunity ceiling and the change should be used only at low viscous influence numbers. Conversely, decrease in capacity of a meter with a type c or e float can readily be made by inverting the float, with a consequent increase in the viscosity ceiling.




**Diluents depress upper explosive limit of hydrogen in air in proportion to complexity of the molecule.**

# Flammable Inhibitors Can Prevent Explosions in Chemical Plants

**It will be new to most people that flammable diluents can be used to prevent explosions in flammable gas mixtures. Molecules that contain many carbon and hydrogen atoms are best for the purpose.**

**ELWYN JONES**

Many industrial processes employ or give rise to flammable gases or vapors in the presence of air or oxygen. Unless adequate precautions are taken, there is a danger that some mechanical, electrical or human failure sooner or later may ignite an explosive mixture with disastrous consequences. For an explosion to occur, the gases and vapors must be present in explosive proportions, and there must also be a source of ignition. If the occurrence of explosive mixtures can be avoided, the danger is averted. If not, all potential sources of ignition must be excluded and measures taken to contain or control the explosion.

The present discussion is not concerned with sources of ignition and their exclusion, excepting only the type of ignition usually described as spontaneous. The object is rather to examine the problem of rendering explosive mixtures innocuous while still preserving the ratio between the reactants necessary to insure maximum reactivity.

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### FLAME SUPPRESSION METHODS

An explosive mixture of say hydrogen and air may be diluted with either hydrogen or air until the point is reached at which flame ceases to propagate. When the diluent is hydrogen, the limiting mixture is called the "upper" explosion limit; when the diluent is air, the limiting mixture is called the "lower" explosion limit. These limits vary depending on the conditions and we should state that the numerical values used here refer to upward flame propagation in 2 in., or 5 cm., diameter tubes at normal temperature and pressure. Thus, the lower explosion limit of hydrogen in air is taken as 4 percent (by volume) of hydrogen and the upper limit as 75 percent.[3] For simplicity, air will be assumed to consist of 20 percent of oxygen and 80 percent of nitrogen, i.e. $(0.2\ O_2 + 0.8N_2)$, so that the lower explosion limit of hydrogen in air may be represented as $[4H_2 + 96(0.2\ O_2 + 0.8N_2)]$ and the upper limit as $[75H_2 + 25(0.2\ O_2 + 0.8N_2)]$. We shall be dealing with a constant volume of the reacting mixture, the unit being 100 moles.

Now, suppose that, by the use of a suitable catalyst at a particular temperature and pressure, hydrogen can be made to react with oxygen to form hydrogen peroxide and that we wish to operate a peroxide plant utilizing atmospheric oxygen. The mixture of hydrogen and air likely to give the maximum speed and efficiency of conversion is that in which hydrogen and oxygen occur in their combining proportions, namely, 1:1. This will require five volumes of air to one of hydrogen. The ideal working mixture would thus contain 16.7 percent

of hydrogen and 83.3 percent of air and may be represented [$16.7H_2$ + $83.3(0.2\ O_2 + 0.8N_2)$]. If all goes well, our hypothetical process may be expected to give [$16.7H_2$ + $83.3(0.2\ O_2 + 0.8N_2)$] → $16.7H_2O_2$ + $66.7N_2$, so that an ideal plant would presumably yield 16.7 volumes of hydrogen peroxide for every 100 volumes of gas entering the reactor.

Note, however, that the composition of the reacting mixture is intermediate between the upper and lower explosion limits. Therefore, unless sources of ignition are rigidly excluded, explosions may be expected. Supposing the required catalyst temperature is at or near the ignition temperature of this mixture, then a potential source of ignition is always present and explosions are liable to become a recurrent process feature.

With the lower limit mixture, the plant will at best give [$4H_2$ + $96(0.2\ O_2 + 0.8N_2)$] → $4H_2O_2$ + $16N_2$ + $76(0.2\ O_2 + 0.8N_2)$; and with the upper limit mixture, [$75H_2$ + $25(0.2\ O_2 + 0.8N_2)$] → $5H_2O_2$ + $20N_2$ + $70H_2$. It will be seen, therefore, that this method of eliminating the explosive reaction reduces plant capacity to roughly one-quarter of its theoretical value.

### USE OF DILUENTS

An alternative method of suppressing the explosive reaction is to add an inert diluent, such as nitrogen, to the correctly proportioned mixture of hydrogen and air. The explosion limits for mixtures of hydrogen, air and nitrogen are known and we find that for such a mixture containing equal volumes of hydrogen and oxygen, the explosion limit is [$4.7H_2$ + $23.3(0.2\ O_2 + 0.8N_2)$ + $72N_2$]. With this mixture, the plant might give [$4.7H_2$ + $23.3(0.2\ O_2 + 0.8N_2)$ + $72N_2$] → $4.7H_2O_2$ + $90.7N_2$. Evidently, the second method is no better than the first.

Now, suppose that, instead of adding an inert diluent to the balanced mixture of hydrogen and air, we decide to add a flammable gas like methane, and operate at the upper explosion limit. On referring to the explosion limit data for mixtures of hydrogen, methane and air, we discover that the upper explosion limit for the mixture containing equal volumes of hydrogen and oxygen is [$15H_2$ + $73(0.2\ O_2 + 0.8N_2)$ + $12CH_4$]. Using this mixture, our peroxide plant may be expected to give [$15H_2$ + $73(0.2\ O_2 + 0.8N_2)$ + $12CH_4$] → $15H_2O_2$ + $58\ N_2$ + $12CH_4$. The interesting fact emerges that suppression of the explosive reaction has been accomplished this time with a reduction in plant capacity of only about 10 percent. Had we used butane or pentane instead of methane, the reduction in output would have been even less. Evidently we have here a simple method of flame suppression which does not seriously handicap production and which may enable chemical processes to be operated at temperatures hitherto considered unsafe or impracticable.

### GENERAL USE OF METHOD

We shall now endeavor to show that this phenomenon is not peculiar to the hydrogen-methane-air system but is a characteristic of gaseous explosive systems in general. To derive a general formula, it will be convenient to make use of Le Chatelier's rule which enables the explosion limit of a multi-component mixture of flammable gases and air to be expressed in terms of the explosion limits of the individual components. This well-known rule is a formal expression of the experimental finding that mixtures formed by combining any number of limit mixtures of the same kind (i.e., upper or lower) in any proportions whatsoever are themselves limit mixtures. In general, agreement between observed limits and those calculated by Le Chatelier's rule is good.[8] Although some discrepancies have been noted by White,[10,11] the greatest divergencies occur in the direction which makes the calculated figures tend to underestimate the effect of a flammable diluent on the upper limit.

As before, we will assume an oxidation process involving an explosive medium. However, this time the reactants will consist of any volatile fuel $A$, and any gaseous oxidizing medium $X$. To yield the required product, the two components must react together in the proportions of $n$ volumes of the combustible to $(100 - n)$ volumes of the oxidizer. That means an $n$ percent mixture of $A$ in $X$ or, in our present notation $[nA + (100 - n)X]$. This mixture, we assume, is intermediate between the upper and lower explosion limits of $A$ in $X$. We propose to suppress the explosive reaction by adding another flammable ingredient $B$.

If the upper explosion limit of $A$ in $X$ is $a$ percent, or $[aA + (100 - a)X]$, and the upper explosion limit of $B$ in $X$ is $b$ percent, or $[bB + (100 - b)X]$, then, according to Le Chatelier's rule, any mixture formed by combining these two in any proportions is also an upper limit mixture. Hence, by taking one part of the first limit mixture and $x$ parts of the second, we obtain the following limit mixture:

$$[aA + (100 - a)X] + x[bB + (100 - b)X] \quad (1)$$

in which the ratio of the oxidizer $X$ to the original combustible $A$ is seen to be $(100 - a)/a + x(100 - b)/a$.

The first term $(100 - a)/a$ will be recognized as the ratio of $X$ to $A$ in the limit mixture for $A$ in $X$. Hence, the addition of the second limit mixture has had the effect of increasing the proportion of $X$ relative to $A$ without incurring the danger usually associated with such a change. In other words, $A$ and $X$ are now mixed together in proportions which, but for the presence of the flammable diluent $B$, would be liable to explode. Moreover, by a suitable choice of the arbitrary quantity $x$, the ratio of $A$ to $X$ can be varied at will.

To determine the precise amount of $B$ required to produce a limit mixture in which the ratio of $A$ to $X$ coincides with the combining proportions, we have only to equate the two expressions for these ratios, that is:

$$(100 - a)/a + x(100 - b)/a = (100 - n)/n \quad (2)$$

This gives:

$$x = 100(a - n)/n(100 - b) \quad (3)$$

in which all the quantities on the right hand side are known.

Applying this formula to our first example, we have $a = 75$, $b = 14$ and $n = 16.7$. This gives $x = 4$ and the correct limit mixture to use in this case comes out to be [$75H_2$ + $25(0.2\ O_2 + 0.8N_2)$] + 4[$14CH_4$ + $86(0.2\ O_2 + 0.8N_2)$] which may be rewritten as 5[$15H_2$ + $74(0.2\ O_2 + 0.8N_2)$ + $11CH_4$]. Comparison with the earlier discussion of hydrogen-methane-air will show that the calculated result agrees well with the result derived from experimental data.

If we now give $b$ the value 8, which corresponds roughly to the upper explosion limit for butane-air mixtures, we find that $x = 4.5$ and the final result becomes [$15.6H_2$ + $77.9(0.2\ O_2 + 0.8N_2)$ + $6.5C_4H_{10}$] → $15.6H_2O_2$ + $62.3N_2$ + $6.5C_4H_{10}$. Thus, the use of butane as the flame-suppressing agent brings the loss of production down to about 6 percent.

### CHOICE OF DILUENT

Substituting the value of $x$ from Eq. (3) in Eq. (1), the correctly proportioned limit mixture for the general case is found to have the following composition:

$$a(100 - b)[nA + (100 - n)X] + 100(a - n)bB \quad (4)$$

It will be noted that as $b$ decreases the term involving $A$ and $X$ increases and the $B$ term decreases—that is, the ratio of reactants to diluent increases

and the efficiency of the process goes up. It appears, therefore, that while any flammable diluent may be made to serve our purpose, it is much better to choose one with a low upper explosion limit in admixture with X. This point is illustrated in the superiority of butane over methane in our last example.

The indicated course is, therefore, to consult a reliable table of explosion limits and select for our diluent the flammable gas or vapor having the lowest upper explosion limit. Unfortunately, not very many upper explosion limits are available, especially for mixtures of volatile fuels with oxygen, nitrous oxide, etc. Also, there are other complicating factors which make the best choice in any particular case uncertain without some preliminary exploration.

Suppose we represent our flammable diluent as $C_xH_y$ so that its complete combustion is given by:

$$C_xH_y + (x + y)O_2 \rightarrow xCO_2 + 2yH_2O \quad (5)$$

One volume of the diluent thus requires $(x + y)$ volumes of oxygen for its complete combustion. By increasing x, or y, or both, we can in theory make the quantity $(x + y)$ as large as we please. In other words, if the products of the explosive reaction are carbon dioxide and steam, a diluent having a complex molecule composed of a large number of oxidizable atoms will require a very large volume of oxygen before it can take part in an explosion. (The same argument applies if we assume the explosion products to be CO and $H_2O$, or even CO and $H_2$. In the latter case, of course, the amount of oxygen required increases only with x, the number of carbon atoms in the molecule.) If a simple flammable gas like hydrogen has to share a limited supply of oxygen with a complex gaseous fuel of this sort so that both can participate in the same explosion, the bulk of the oxygen is claimed by the complex gas. If the whole of the oxygen available cannot satisfy the minimum needs of both, then neither can explode. This principle, like Le Chatelier's rule and Payman and Wheeler's flame-speed rule,[8] derives from the ordinary laws of simple mixtures. According to this view, a heavy organic vapor is likely to have an inordinate effect in depressing the upper explosion limit. Hence, a desirable property of the flame-suppressing diluent is that its molecule should contain a large number of carbon and hydrogen atoms.

The effect of this factor may be seen in headpiece, which represents graphically the explosion limits of hydrogen-air mixtures diluted with carbon dioxide, ammonia, methane, butane and hexane. The continuous lines are drawn from experimental determinations by White[10, 11] and the broken lines are calculated from the upper limits of the respective components, using Le Chatelier's rule. The ordinates represent the percentage of added diluent and the abscissas show the percentage of hydrogen. The difference between the sum of these two quantities and 100 gives the percentage of air in the limit mixture.

It will be apparent from the graph that heavy flammable vapors like butane and hexane have a remarkable depressing effect on the upper explosion limit of hydrogen-air mixtures—furthermore, that the order of increasing effectiveness as flame inhibitors coincides with the order of increasing molecular complexity, namely, hydrogen (2 atoms), carbon dioxide (3), ammonia (4), methane (5), butane (14) and hexane (20).

### NON-FLAMMABLE DILUENTS

Although these results bear out our calculations, it is interesting to note that the inert diluent, carbon dioxide, seems to fit into the general scheme, suggesting that poly-atomic inert diluents may also be effective flame inhibitors. Indeed, it has been shown by Jorissen and his collaborators[9] that vapors of relatively nonflammable organic liquids, notably alkyl halides such as carbon tetrachloride, trichloroethylene and methyl bromide, have pronounced flame-quenching properties. Other vapors recommended are sulphuryl chloride, silicon tetrachloride, silicochloroform and phosphorus oxychloride. Unfortunately, the tests were made in narrow tubes so that direct comparison with the present figures is not possible.

The great advantage of the nonflammable inhibitor is that it can be used in circumstances where the supply of oxygen is unlimited, as when a fire occurs in the open. On the other hand, in the confined spaces of a chemical plant, where the object is prevention rather than cure, flammability can be turned to good advantage. Actually, some of the vapors recommended are not strictly nonflammable and can form explosive mixtures with oxygen, oxides of nitrogen and, in some cases, air so that the dividing line seems rather arbitrary.

Other manifestations of the flame-suppressing action of complex organic bodies have been discussed elsewhere.[4] Here the inference was drawn that combustible inhibitors have the advantage where an explosive reaction involves oxidation. This is true especially in closed systems, since excess fuel promotes the formation of incompletely oxidized reaction products, thereby reducing the potential energy of the chemical reaction. This raises an issue of considerable practical interest in many industrial processes, because the material to be oxidized is itself often a complex organic vapor. Then the question arises whether or not some advantage can be taken of the inherent flame-suppressing property of the fuel.

### SELF-QUENCHING

It is axiomatic that a chemical change in a gaseous mixture is potentially explosive if the reaction is sufficiently energetic. The critical energy factor which is relevant to the present discussion is the minimum energy that is sufficient to make the reaction self-propagating, and so independent of ordinary means of control. This we can ascertain very simply by taking the calorific value of the explosion limit mixture. The relative constancy of this quantity has often been remarked, and Jones and White[4] suggested that Le Chatelier's rule holds because the calorific value of all limit mixtures is substantially constant, and vice versa. There is, therefore, strong support for the view that this critical energy factor not only exists but is roughly the same for all gas mixtures.

For our next example, we shall take methyl alcohol, $CH_3OH$, which is a more complex fuel than hydrogen but is no so complex as to make the exercise unduly involved. The lower explosion limit of methanol in air is 7 percent. In our notation this is $[7CH_3OH + 93\ (0.2\ O_2 + 0.8N_2)]$, and we can assume with some confidence that combustion in this over-oxidized mixture goes to completion, or $[7CH_3OH + 93(0.2\ O_2 + 0.8N_2)] \rightarrow 7CO_2 + 14H_2O + 42N_2 + 40.5\ (0.2\ O_2 + 0.8N_2)$.

The heat of combustion of methanol to carbon dioxide and steam is 162 kcal. per g. mole.*, so that the critical calorific value for explosion in methanol-air would appear to be $7 \times 162$, or roughly 1,130 kcal. per unit volume of 100 moles. Any reaction which generates more than 1,130 kcal. of heat per unit volume should, therefore, be regarded as potentially explosive. Thus we have a simple criterion by which to judge which of the oxidation reactions of methanol are explosive and which are not. We shall now examine some of those reactions.

* Here, as elsewhere in this article, the figures refer to the gaseous phase at atmospheric pressure.

Let us begin with the complete oxidation reaction:

$$CH_3OH + 1\tfrac{1}{2}O_2 \rightarrow CO_2 + 2H_2O \quad [+ 162 \text{ kcal.}]$$

Although the products of this reaction are of no commercial value, we shall suppose that, wittingly or unwittingly, our catalytic oxidation plant is supplied with a mixture of methanol and air in the proportions appropriate to this reaction, i.e., $CH_3OH + (1\tfrac{1}{2}O_2 + 6N_2)$. The result may be $[11.8CH_3OH + 88.2(0.2\ O_2 + 0.8N_2)] \rightarrow 11.8CO_2 + 23.6H_2O + 70.6N_2$.

The calorific value of this mixture is 1,910 kcal. per unit volume and we deduce that this is an explosive reaction capable of great violence. Here, however, our purpose is to prevent explosions by avoiding mixtures such as this. Still, it is relevant to note the implication that appreciable quantities of carbon dioxide appearing in the products of a catalytic oxidation process mean a hazardous situation.

Now we shall assume that oxidation of the methanol is incomplete in the sense that the products of the reaction are CO and steam, or:

$$CH_3OH + O_2 \rightarrow CO + 2H_2O \quad [+ 94 \text{ kcal.}]$$

Making the necessary adjustment in the methanol-air ratio, we have $[16.7CH_3OH + 83.3(0.2\ O_2 + 0.8N_2)] \rightarrow 16.7CO + 33.3H_2O + 66.7N_2$, and the calorific value of the mixture, based on this reaction, is found to be 1,570 kcal. per unit volume. Again we are dealing with a potentially explosive reaction. Again the presence of excessive amounts of carbon monoxide in the products of a catalytic oxidation process, although not so disturbing as carbon dioxide, is another sign of inefficiency, instability and possible danger.

The next stage—that in which only one oxygen atom is required per molecule of methanol—is the one with commercial potentialities. In passing, it may be recollected that the elementary definition of an atom describes it as the smallest part of an element which can take part in a chemical change. If this is true, then chemical changes must involve integral numbers of atoms and our 3:2:1 stages follow logically from the elementary principles of chemistry.

For reasons which will appear later, we shall take the first stage in the oxidation of methanol to be:

$$CH_3OH + \tfrac{1}{2}O_2 \rightarrow HCHO + H_2O \quad [+ 37 \text{ kcal.}]$$

The correctly proportioned mixture of methanol and air is now $[28.6CH_3OH + 71.4(0.2\ O_2 + 0.8N_2)]$ and on the basis of the first stage reaction, the result would be $[28.6CH_3OH + 71.4(0.2\ O_2 + 0.8N_2)] \rightarrow 28.6HCHO + 28.6H_2O + 57.1N_2$. The calorific value of this mixture, assumed to react as above, is found to be 1,060 kcal. per unit volume.

A point which we have overlooked hitherto is that the vapor pressure of methanol is too low to give a concentration of 28.6 percent in air at ordinary temperatures. In order to realize the conditions we have postulated, the reactants must be preheated. Any heat supplied from outside must surely be added to that generated by the chemical reaction. (White,[10, 11] demonstrated that the flame temperature [heat content?] at the explosion limit is not altered by raising the initial temperature of the gas.) Assuming, then, that we raise the temperature of the incoming gases 50 deg. C. above normal, the amount of heat supplied is approximately 40 kcal. per unit volume. This brings the total up to 1,100 kcal. per unit volume and we seem to be in the critical region where explosions may possibly happen but are not likely to be violent. In other words, if we can guarantee to arrest the oxidation of methanol at the end of the first stage, the explosion hazard with this mixture would be slight and there would be no undesirable effect on the products.

To appreciate what is meant by arresting oxidation at the end of the first stage, let us look at the three oxidation stages of methanol in their proper sequence:

$$CH_3OH + \tfrac{1}{2}O_2 \rightarrow H_2O + HCHO \quad [+ 37 \text{ kcal.}]$$

$$H_2O + HCHO + \tfrac{1}{2}O_2 \rightarrow H_2O + H_2O + CO \quad [+ 57 \text{ kcal.}]$$

$$2H_2O + CO + \tfrac{1}{2}O_2 \rightarrow 2H_2O + CO_2 \quad [+ 68 \text{ kcal.}]$$

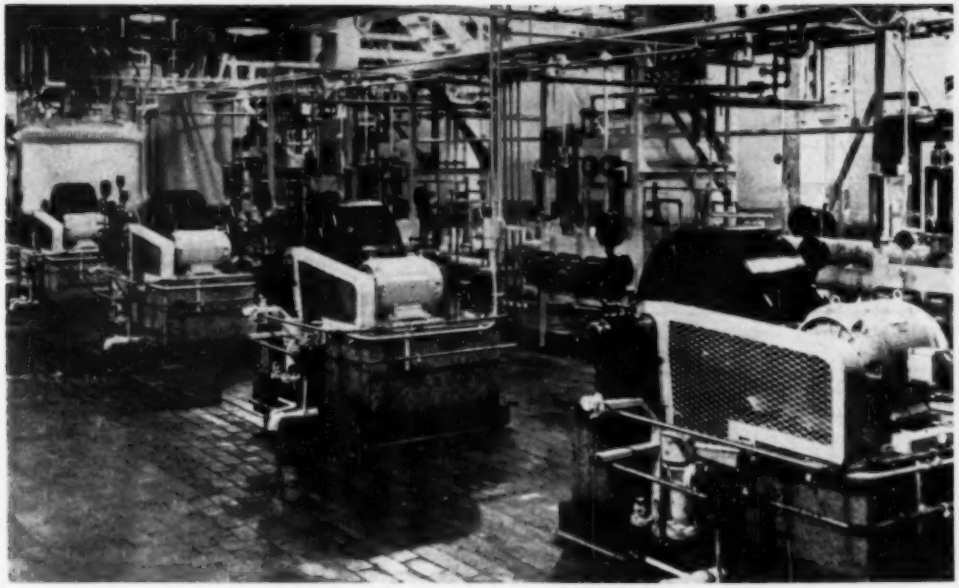
It would appear that the first stage is the oxidation of the hydrogen released by the primary decomposition of methanol, the second is the oxidation of the hydrogen released by the decomposition of the formaldehyde and the final stage is the oxidation of the carbon monoxide left over. If, with the aid of a suitable catalyst, we can bring about the rapid dehydrogenation of methanol at temperatures at which the decomposition of formaldehyde is relatively slow, the oxidation of methanol can apparently be arrested at the end of the first stage. If we fail in this, then oxidation may proceed to the second and, possibly, the third stages, as analyses of the oxidation products show.[3] The second stage oxidation in this particular mixture would give $[28.6CH_3OH + 71.4(0.2\ O_2 + 0.8N_2)] \rightarrow 28.6H_2O + 14.3CO + 57.1N_2 + 14.3CH_3OH$; and the third stage, $[28.6CH_3OH + 71.4(0.2\ O_2 + 0.8N_2)] \rightarrow 19H_2O + 9.5CO_2 + 57.1N_2 + 19CH_3OH$.

The calorific value of the former is 1,350 + 40 = 1,390 kcal. per unit volume and that of the latter 1,540 + 40 = 1,580 kcal. per unit volume. It follows, therefore, that if oxidation tends to go beyond the first stage, not only is the formaldehyde content of the products reduced, but also the explosive potential of the mixture is increased. Moreover, the extra heat tends to raise the temperature and so accelerate the reaction, a condition which may ultimately lead to spontaneous ignition.

Whereas it is undesirable to decompose the formaldehyde, it is highly desirable to encourage the dehydrogenation of the methanol, irrespective of whether the hydrogen is oxidized or not. It is known[4, 9] that the primary stage in the pyrolysis of methanol is $CH_3OH \rightarrow HCHO + H_2$ [− 20 kcal.]. It will be noted that this is an endothermic process so that, by the simple expedient of introducing excess methanol, we can combine this heat-absorbing reaction with the first oxidation stage and so bring the calorific value down not only to a figure consistent with safety but to an extent which will enable the temperature to be controlled. The latter point is outside the scope of the present discussion. However, it will suffice to point out that we seem here to have found the cause of the other flame-quenching property of complex organic fuels, the one they share with non-flammable complex organic vapors. Any vapor capable of endothermic decomposition at temperatures below the critical value for the explosive reaction, which according to White[10, 11] is usually in the region of 1,400 deg. C., will have a marked inhibiting effect. Thus, by its capacity to absorb heat, it lowers the explosive potential of the gas mixture.

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PENICILLIN plant uses this battery of Podbielniak extractors to get the product out of the very dilute broth.

# LIQUID-LIQUID EXTRACTION

**Here is an up-to-date roundup of this important chemical engineering unit operation. The authors deal with process technology, equipment performance and characteristics, and some basic considerations in the selection of solvents.**

R. L. VON BERG AND H. F. WIEGANDT

CHEMICAL ENGINEERING REPORT—JUNE 1952

LIQUID-LIQUID extraction is one of the important chemical engineering unit operations practiced on a major industrial scale. Many chemical engineers, however, are less familiar with extraction than they are with other unit operations, such as distillation.

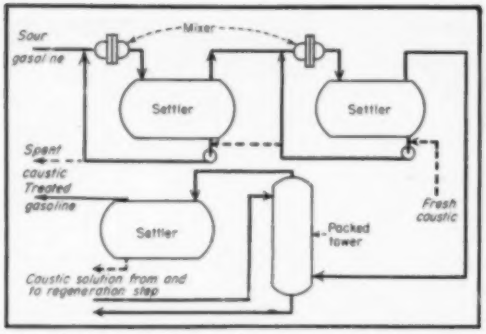
*Limited coverage in school*

One reason for this condition is that extraction is frequently quite complex and is therefore given only limited coverage in most undergraduate courses. Another reason has been the relative scarcity of published engineering information on extraction. For example, it is much easier to find good information on the proper design of a bubble-cap plate than a perforated plate, on the maximum liquid and vapor rates than liquid-liquid flooding rates, or on distillation plate efficiencies than extraction tray efficiencies.

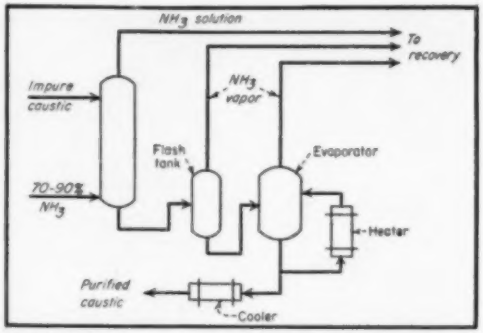
Much helpful information has become available in recent books by Treybal[4] and Sherwood and Pigford[5]. Commercial extraction equipment has been reviewed by Morello and Poffenberger[1]. Annual reviews of extraction, currently compiled by Treybal[6], cite the important references. This *Chemical Engineering* report is designed to bring the non-specialist reader up to date on some of the important aspects of liquid-liquid extraction.

*For the non-specialist*

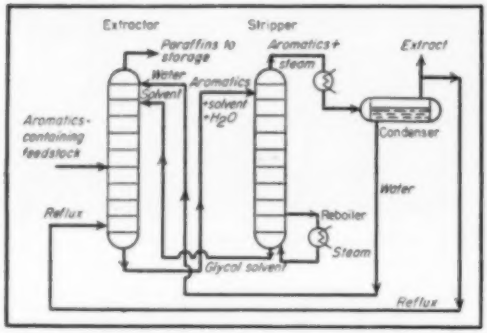
ROBERT L. VON BERG and HERBERT F. WIEGANDT are both associate professors of chemical engineering at Cornell University, Ithaca, N. Y. For more about the authors and one of their pet research projects, see p. 200.



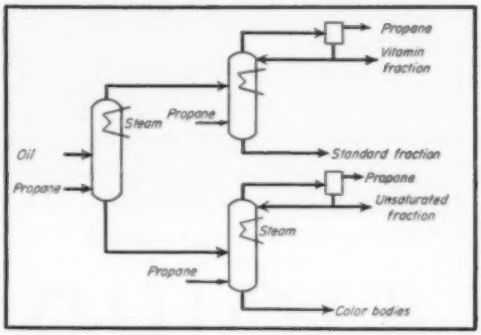

SULPHUR compounds in gasoline are extracted with caustic.




AMMONIA extracts traces of salt from electrolytic caustic.




UDEX process extracts aromatics from reformed naphtha.




SOLEXOL process uses propane to fractionate vegetable oils.

## Where Is Liquid-Liquid Extraction Used Commercially?

*Petroleum refining*

On a sheer volume basis, the petroleum industry is the largest user of operations involving liquid-liquid extraction. Although distillation effects the primary separation of crudes or cracked products into desired fractions, further refining of these fractions by extraction is often necessary. The reason is simply that performance characteristics of fuels and lubricants depend to a large extent on the kinds of molecules as well as on their boiling ranges.

The presence of sulphur compounds in gasoline, for example, is highly objectionable, particularly where high octane ratings are desired. Desulphurization is becoming more important as the industry turns to high-sulphur crudes.

*Caustic washing*

An old but still widely practiced process for removing sulphur from gasoline is extraction with caustic soda in a mixer-settler arrangement. Caustic is recycled until spent, then discarded.

As mercaptans increase in molecular weight, however, their distribution coefficients progressively favor the gasoline phase. Multi-stage caustic washing has been giving way to extraction with alkaline solutions containing mercaptan-solubilizing ingredients, such as methanol, potassium isobutyrate, or sodium naphthenate. These solutions can be regenerated either by thermal decomposition of the weak mercaptides formed or by oxidation of the mercaptans to disulphides by air-blowing.

*Extraction with $SO_2$*

The affinity of liquid sulphur dioxide for aromatics has led to its widespread use in extracting aromatics from the paraffinic and naphthenic hydrocarbons in petroleum fractions. Known as the Edeleanu process, this process has been used for more than forty years for refining various products. Since aromatics have poor burning characteristics, chief use of $SO_2$ extraction in the early days was to improve the quality of kerosene for lamps and stoves. Today it is used also for refining naphtha, light lubricating oils and diesel fuels, and is even being used to upgrade distillate stocks for catalytic cracking.

*Edeleanu process*

The process uses liquid $SO_2$ at a temperature of about 20 deg. F. to produce an oil virtually free of aromatics. The extract, or aromatic fraction, still contains about 25 percent of non-aromatics. Separation of the latter by distillation would be no more successful than distillation of the original oil. However, if the $SO_2$ aromatic solution is itself treated with a high-boiling kerosene, the non-aromatics are displaced. The resulting extract, after removal of $SO_2$ by stripping, can then be separated into aromatic and paraffin fractions by distillation. The high-boiling kerosene and $SO_2$ are recycled.

*Lube oil refining*

Liquid-liquid extraction plays an important role in the refining of lubricating oils by removing gum-forming, unstable compounds of low viscosity index. A number of processes using

various solvents are in wide use. Among these solvents are furfural, phenol, nitrobenzene and Chlorex (dichlorodiethyl ether). As in the removal of mercaptans from gasoline, mixed solvent systems are sometimes used, such as $SO_2$ plus benzene.

*Use of reflux*

In general, the selectivity of these separations can be increased with the use of reflux, directly or induced. In the case of extraction with phenol, for example, induced reflux is obtained by the simple expedient of injecting water into the extract system and thereby throwing some of the extracted hydrocarbons out of solution.

The Duo-Sol process, on the other hand, uses a counterflow of propane against the extraction solvent, a blend of cresol and phenol known as Selecto. The oil is fed to an intermediate stage of a battery of mixer-settlers, where the desired fraction goes into the propane phase. The Selecto flows countercurrent to the oil-propane phase, with the result that both deasphalting and solvent refining are accomplished at the same time.

*Propane as a solvent*

Propane differs from the other solvents used in lube oil refining in that it is a solvent for the desired paraffinic constituents and an antisolvent for the undesirable asphaltic substances, particularly so as the temperature is increased. Consequently it is possible with volume ratios of propane to oil of about 10 to 1 and at temperatures of 150 to 170 deg. F. to obtain selective asphalt elimination in a countercurrent operation.

*Udex process*

In view of the extreme interest today in the recovery of aromatics from catalytically reformed naphthas, it is not surprising to find a process using liquid-liquid extraction competing for favor with others using extractive distillation or adsorption. The extraction process which has received the most attention commercially is the Udex process, in which aqueous diethylene glycol is used as the solvent for the aromatics (benzene, toluene, xylene).

Feedstock enters a multi-tray, multi-feed extractor in which the glycol flows countercurrent to the feed. Water mixed with the glycol controls its solubility characteristics; it reduces solvency but allows good selectivity. Solubility reduction, of course, calls for a higher solvent-feed ratio. A reflux stream of aromatics entering near the bottom of the extractor forces any paraffinic carryover out of the glycol phase.

### ANIMAL AND VEGETABLE OILS

The use of liquid-liquid extraction for the separation of animal and vegetable fats and oils into various fractions is another recent development. These materials may contain vitamins, sterols, proteins and other minor constituents, in addition to fats and oils of many different molecular weights and degrees of unsaturation. It is somewhat surprising, therefore, to find that good separations may be achieved with comparative ease.

*Solexol process*

The Solexol process, which uses liquid propane as the solvent, is based on experience gained in the propane deasphalting of lubricating oils. The system must, of course, operate under pressure, because the normal boiling point of propane is −42 deg. F., and at room temperature its vapor pressure is about 135 psi. It is also necessary to stay below the critical temperature of about 212 deg. F. in order for the propane to remain a liquid. The versatility of this process results from the fact that above a critical solution temperature the solubility of a given fat in propane decreases as the temperature is increased. Below this temperature the two are miscible. Thus, advantage can be taken of the different critical solution temperatures which are characteristic of individual compounds.

*Decolorizing*

The most general application to date is for decolorizing purposes. One recent installation decolorizes 200,000 lb. of tallow per day and obtains a 98 percent recovery with a propane to fat ratio of 17 to 1 by volume. The propane phase is continuous and discharges with the product dissolved in it from the top of the extractor. Propane is recovered by evaporation and stripping for return to the process. In another plant, menhaden oil is separated by propane extraction into three major fractions and a residue at a rate of 95,000 lb. per day.

*Vitamin recovery*

In the case of fish oils, such as cod, halibut, sardine, menhaden, etc., the vitamin concentrate is a primary objective. It may also be desirable to recover as one fraction a premium raw material for paint manufacture—the fraction containing the highly unsaturated molecules. The more saturated fractions may be hydrogenated and further processed for edible fat manufacture.

Furfural is also used as an extraction solvent for the recovery of drying oils and vitamin concentrates. Since furfural has an affinity both for color bodies and unsaturated glycerides, these materials are both picked up in the extract layer. In keeping with this distinction from propane as a solvent is the observation that the addition of naphtha, which, like propane, is also paraffinic, aids in the sharpness of the separation.

*Furfural vs. propane*

Furfural must be protected against oxidation, and it is much more expensive than propane. Losses can be minimized, however, and the furfural operation does not require pressure equipment. In addition, the solvent-oil ratios used with furfural are considerably less than with propane.

Wood rosin (90 percent abietic acid), almost all of which is obtained by naphtha extraction of pine-tree stumps, is improved in quality by subsequent countercurrent solvent extraction of the naphtha solution. Furfural has been generally used as the solvent for this extraction since 1927. This process makes possible the manufacture of products such as water-white ester gum.

*Tall oil refining*

In the sulphate pulp process, water-insoluble tall oil is recovered from the discarded cooking liquors. This oil is a complex mixture of rosin and fatty acids. Although cheap, it has not been refined on a major industrial scale into its important constituents. Because of its lucrative possibilities, however, the refining of tall oil is of more than academic interest. Extraction with propane produces cuts differing in unsaturation and fatty acid content, but evidently considerable research and development still is required to develop a paying process which produces valuable specific products.

Extraction plays an important part in the recovery of byproducts from the destructive distillation of coal. Such operations are usually of a simple contacting-settling type, such as the removal of acidic materials with alkaline agents or removal of basic materials with acidic agents. Phenolic compounds and amines are examples. Improvement in yield and reduction in chemical consumption result from the recovery of phenolic compounds by methanol or methanol-hexane extraction of the tar mixture.

*Phenol disposal*

The industry is greatly concerned with the disposal of phenolic wastes, particularly those from the ammonia stills. Solvent extraction processes in which benzene is commonly used result in a 95 to 98 percent removal of phenol and render the wastes suitable for discharge into most public waters. Both mixer-settlers and columns are used.

ANTIBIOTICS

*Penicillin et al.*

The pharmaceutical industry depends upon extraction techniques for the recovery and purification of antibiotics. Penicillin is extracted from an acidified, filtered fermentation liquor in which its original concentration is less than 0.02 lb. per cu. ft. Amyl acetate is the solvent. Deterioration losses are cut by rapid processing.

Podbielniak centrifugal extractors have been widely applied for this operation. Further purification and concentration are brought about by extraction into a neutral buffer solution, acidification and re-extracting into amyl acetate, and finally re-extracting with a neutral buffer solution which is evaporated by freeze-drying.

Bacitracin is extracted from filtered fermentation liquor with butanol, also using centrifugal extractors. No re-extraction is necessary, however, the final powder being obtained by evaporation of butanol from the solution after water dilution, followed by vacuum drying.

*Acetic acid recovery*

In the manufacture of cellulose acetate, the recovery of acetic acid is most economically carried out by countercurrent extraction with an organic solvent, such as ethyl acetate or isopropyl ether.

*Phenol manufacture*

The Raschig process for phenol manufacture is dependent on recovery of unreacted materials and the cycling of HCl within the process in order to be competitive with other phenol processes. Several of the recovery steps involve extraction, such as the removal of phenol from water and from aqueous hydrochloric acid in column extractors with a benzene counterflow.

*Caustic purification*

Somewhat unusual among extraction processes is one which involves no organic chemicals. A recently developed process for purifying caustic soda of the last traces of salt does this job by extraction with ammonia. At least four extraction units have been built, each having a capacity of over 100 tons per day.

Caustic of 50 percent concentration flows countercurrent to ammonia of 70 to 95 percent concentration; the system is under pressure to keep the ammonia liquefied. The salt concentration is reduced to 0.08 percent. As the ammonia concentration is increased it also extracts water to raise further the concentration of NaOH in the purified caustic. About 5 percent of the NaOH is also extracted. The ammonia is recovered by distillation and scrubbing.

## How To Select Equipment for Extraction Operations

All liquid-liquid extraction processes must include the following sequence of steps: (1) Production of an intimate contact of feed mixture with solvent; (2) separation into two liquid phases; (3) recovery of solute from extract phase and recovery of solvent from both phases.

A single equilibrium contacting of feed mixture with solvent is spoken of as a theoretical stage. Commercial extractions usually require only a few theoretical stages, a requirement that can be satisfied by many different types of equipment.

*Need for turbulence*

The intimate contacting of the two liquid phases is brought about by various devices which produce localized turbulence. This turbulence produces a dispersion of one phase in the other and provides a large surface area for mass transfer at the phase boundary. It also aids mass transfer to the phase boundary because of movement within each phase relative to this surface.

Best results are obtained when production of new surface is continuous. The drops of dispersed liquid should be collected and redispersed for most efficient extraction. In support of this principle, it has been shown that a large portion of the total mass transfer occurs at the point of drop formation.

Frequently a compromise in the degree of mixing is necessary to permit separation of the phases. Separations are usually accomplished by gravity settling. For more difficult cases, coalescence may be promoted by special fine packings or by use of centrifugal force.

*Important properties*

From these remarks it is evident that surface and interfacial tensions, viscosities and relative densities of the phases are very important properties of any extraction system and will probably govern to a great extent the type of equipment used. The presence of emulsifying agents and solids has an even greater effect on the choice of equipment.

It is generally found, therefore, that the choice of extraction equipment is governed by the properties of the particular system and the necessity of maintaining efficient and reliable operation. For example, materials that are easily emulsified, have small density differences, contain solids, or are corrosive present special problems which require specialized equipment.

*Performance data*

Table I presents a concise summary of the performance characteristics of commercial equipment used for liquid-liquid extraction. Capacities and extraction efficiencies, expressed as height equivalent to a theoretical stage (H.E.T.S.) or number of stages, are average figures based on data from actual commercial operations or on information obtained from equipment manufacturers.

It should be recognized that extraction equipment is not run close enough to flooding con-

**Table I—Performance of Commercial Extraction Equipment**

| | Liquid Capacity, Combined Streams, Cu. Ft./(Sq. Ft.) (Hr.) | H.E.T.S. Ft. | Plate Spacing | Plate Efficiency | Typical Applications |
|---|---|---|---|---|---|
| Mixer-settler | ——— | Approx. 1 stage/unit | | 75–100% | Duo-Sol lube oil process |
| Spray column | 50–250 | 10–20 | ——— | ——— | NaCl from NaOH using $NH_3$ |
| Packed column | 20–150 | 5–20 | ——— | ——— | Phenol recovery |
| Perforated-plate column | 10–200 | 1–20 | 6–24 in. | 30% for 4–8 in. plate spacing | Furfural lube oil process |
| Koch column | 10–200 | 2–7 | 16 in. | 20–75% | Gasoline desulphurization |
| Baffle column | 60–105 | 4–6 | 4–6 in. | 5–10% | Acetic acid recovery |
| Bubble-cap column | ——— | 8–20 | 12 in. | 5–10% | ——— |
| York-Scheibel column | 50–100 | 1–2 | 1–2 ft. per mixer unit | 80–100+% | Pharmaceuticals and organic chemicals |
| Podbielniak | To 20,000 gal./hr. | Low: 3–5 stages/unit | | ——— | Antibiotics |
| | 1,000–5,000 gal./hr. | High: 8–20 stages/unit | | | |
| Luwesta | 3,800 gal./hr. | Approx. 3 stages/unit | | ——— | Penicillin extraction |

ditions for operating variations to cause trouble. Flooding is considered to occur when there is appreciable carry-over of feed in extract or solvent in raffinate. In general the flooding point may be as much as 50 to 100 percent above the operating figures given.

*Basis for capacity data*

Capacity can ordinarily be expressed reasonably well as the sum of the feed and solvent streams and is expressed in that fashion here. Surface tension properties, tendency to emulsify, difference in densities, degree of dispersion, etc., all can affect the capacity of extraction equipment considerably.

*Basis for efficiency data*

The measure of extraction efficiency is a function of the properties of both the system and the flow rates of the liquids through the system. For any given system this can be measured in terms of the change of concentration.

Consider a section of a continuous countercurrent tower with solvent passing upward and feed moving down (see diagram).

Assume that the composition of the feed stream (or raffinate) $F_2$ leaving the section is the result of an equilibrium contact with a solvent stream. Knowing the equilibrium data for the system, we can evaluate the composition of this solvent stream (extract). This composition is not that of the entering solvent stream $S_2$, because if it were there would be no driving force for transfer of material, hence no extraction. Actually this composition corresponds to some composition of the solvent stream $S_1$ further up the column.

*Theoretical stage*

This section then is accomplishing the mixing of $S_2$ and $F_1$ to produce an extract $S_1$ and raffinate $F_2$. This operation is a single stage, and the height of column needed is the height equivalent to a theoretical stage.

*Stepwise method*

A graphical method of determining the number of stages needed for extraction using immiscible solvents is shown in the stepwise diagram. Starting at the point of entry of pure solvent, the amount of material transferred in the first stage is expressed by the composition change $(x_1 - x_0)$, whereas the driving force for transfer would vary from $(x_0 - x_{e0})$ to $(x_1 - x_{e0})$. This is identical to $(x_0 - 0)$ to $(x_1 - x_1)$ if the main resistance to transfer is in the raffinate phase.

Considering that the height of a theoretical stage will be directly proportional to the amount of material transferred and inversely proportional to the driving force, it is quite evident that each theoretical stage does not represent the same height of column. Hence it is difficult to assign an efficiency value to a column even when using the same system, if the range of concentrations is different.

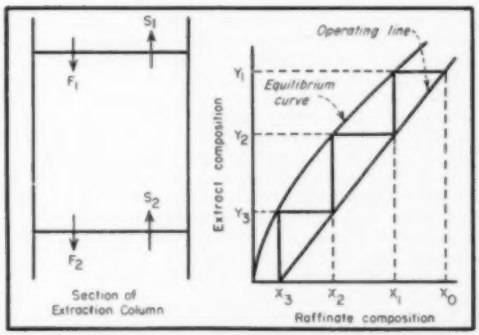
*Differential method*

If, however, we consider only a differential change in concentration, we can define the number of transfer units N by integration of

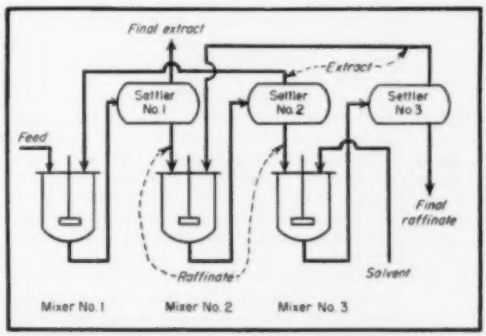
$$dN = \frac{dx}{x - x_{eq}}$$

The height of a transfer unit then becomes

$$H.T.U. = \frac{\text{Column height}}{N}$$




**EFFICIENCIES** are measured in terms of composition changes




**MIXER-SETTLER** system may run batchwise or continuously.

Note that an equilibrium curve parallel to the operating line would produce constant values for H.E.T.S., and in this special case the same values would be obtained by both the stagewise and differential methods.

*H.E.T.S. vs. H.T.U.*

Also the actual amount of solute that must be transferred for a given change in concentration is proportional to the liquid rates. If the rate of transfer remains constant for changing rates, the H.E.T.S. and H.T.U. become directly proportional. However, higher liquid rates result in higher mass transfer rates, so that this direct proportionality is not at all true. Actually in many cases the increase in mass transfer rate just about compensates for the increase in liquid rate.

Extraction efficiencies reported in the literature for various types of equipment have been determined using a variety of systems and flow rates. Reasonable averages of these widely dispersed values are given to present a general idea of efficiency. Because of the nature of these values it makes little difference whether they are labeled H.E.T.S. or H.T.U.

### MIXER-SETTLERS

Extraction may be carried out simply by mixing solvent and feed and then separating the extract and raffinate phases. This operation can be repeated with fresh solvent, or multiple stages may be set up to give a stepwise countercurrent extraction. By using continuous flow in and out of units, continuous countercurrent extraction is achieved.

Illustrated here is a typical three-stage multiple-contact extraction system. Such a system contains three mixer-settler units; material may be handled in batches from one unit to another or it may flow continuously into and out of each unit.

*Mixer design*

The mixer is usually a baffled tank with a turbine or propeller agitator. Jet mixers, injectors, orifice mixers, nozzles and pumps are also used. They are less satisfactory in many cases because contact time is insufficient to permit a reasonable approach to equilibrium. Mixing time can be very short if dispersion is good, probably in many cases less than 1 min.

The separator or settler is usually a tank designed to minimize turbulence caused by the entering or exit liquids. For mixtures having a high degree of dispersion or tendency to emulsify, and for phases having small density differences, liquid-liquid separating centrifugals are often used. These machines are usually of the disk or cream-separator type. For separations of intermediate difficulty beds of glass fiber, screens, packing, etc., are used between the mixer and settler to promote coalescence.

*Settler design*

For separation in a settling tank the petroleum industry uses ½ to 1 hr. for many processes. Shorter times should be possible by proper design—baffling to insure laminar flow in the continuous case and providing for a maximum of interface.

Mixer-settlers are easily designed because they are discrete stages and consist of standard equipment. They will handle almost any extraction problem, including those of emulsification, pressure or elevated temperature. Their chief disadvantage lies in the fact that less than one stage per mixer-settler unit is obtained. For a large number of stages, say 5 to 10, investment costs are high and floor space requirements are excessive.

*Stage efficiency*

Stage efficiency (approach to equilibrium in each mixer-settler unit) will run from 75 to 100 percent. The fact that efficiencies are less than 100 percent is probably due more to incomplete separation of phases rather than insufficient contacting, particularly in tank mixers. Determination of proper settling time, therefore, is the biggest design problem.

Commercial installations of mixer-settlers are very common. Scores of processes make use of a single-stage extraction or washing operation using this type of equipment. Multiple-stage installations are most common in the petroleum industry in such processes as the Duo-Sol lube oil process.

### SPRAY COLUMNS

A spray column is a vertical cylinder through which one liquid flows as the continuous phase, with the second liquid dispersed in the first. Directions of flow, of course, depend on the relative densities of the liquids. There is considerable evidence that a large percentage of the extraction (as much as 40 to 50 percent in many cases) takes place at the point of dispersion. This means that the tower itself is comparatively ineffective, and that redispersion would be much more helpful than increasing the column height.

*Column efficiency*

Low efficiencies may result from coalescence of the droplets or recirculation in the tower, which reduces the true countercurrent action. This latter effect can be reduced by using small-diameter towers in parallel. To prevent flooding, carry-over of one phase in the other, and coalescence of the droplets, towers with enlarged ends may be used. This prevents constriction to flow at the points of dispersion.

*Pros and cons*

Spray columns are the simplest type of extraction equipment in construction and operation. They boast low cost, high capacity and ease of cleaning. However, they have the distinct disadvantage of having a higher H.E.T.S. than other types of extraction columns.

### PACKED COLUMNS

Packing is frequently used to promote the contacting of the liquids flowing countercurrently through a column. Such columns are usually packed with standard materials, such as Raschig rings or Berl saddles. Other materials often used include coke, Carborundum and wood grids. Different standard packings appear to give only slight variations in H.E.T.S.

*Column design*

The packing is often separated into several sections to allow the liquids to redistribute and to make the column easier to pack and unpack. Packed columns have specially designed liquid distributors and settling or separating sections at the top and bottom. In the design of most columns the rule that the ratio of column diameter to packing diameter be not less than 8 to 1 is followed.

Packed columns approach the spray column in simplicity. They can be made to handle almost any corrosion problem at reasonable

cost. Solids will tend to deposit in the packing and cleaning is difficult. The height per stage is high and increases with size of column because of increased channeling.

*Widely used*

In operation the interface between the two liquid phases is usually maintained in the open section at the top or bottom of the column. In rare cases the interface may be carried in the middle of the column. Packed towers are used extensively for extraction in many chemical and petroleum processes.

### PERFORATED OR SIEVE-PLATE COLUMNS

This type of extractor uses the principle of redistributing the dispersed phase into droplets a number of times by passage through plates having a large number of small holes. These perforations usually run $\frac{1}{16}$ to $\frac{1}{8}$ in. in size.

*Many types*

There are many modifications of this general idea, with columns having tray spacings varying from 6 in. to 2 ft. Some designs use small holes in vertical sections of the tray. This construction reduces plugging of the holes by solids. Screens, rather than perforated plates, have been used. In all designs "downcomers" are used to carry the continuous phase from plate to plate.

In operation the dispersed phase collects under or above each plate until sufficient pressure is developed to cause the liquid to jet through the holes and form droplets that move to the next plate.

The dispersed phase should fill less than half the space between plates, which condition requires the proper design of the plates. The degree of extraction is not significantly influenced by hole size over a wide range of diameters, but the hole area determines the liquid capacity of the extractor. Operation of the column with the interface near the middle is common.

*Koch Kaskade*

The Koch Kaskade is an unusual variation of the perforated-plate column. It makes use of vertical perforated plates so arranged that the heavy liquid flowing down is dispersed several times in the stream of light liquid moving against it before dropping to the next plate. Plate efficiencies as high as 75 percent have been experienced with this equipment.

*Pros and cons*

Perforated-plate columns have the advantages of giving good extraction efficiency and yet being fairly simple in construction. They do not have the same restrictions as to size which apply to packed and spray columns. Columns as large as 12 ft. in diameter have been built. They are, however, difficult to design properly and cannot be operated over as great a range of flow rates as other columns. There is little change in plate efficiency for plate spacings above 8 in.; but the H.E.T.S. continues to decrease as plate spacing is reduced below this value.

Perforated-plate columns are used in numerous processes, such as the refining of lube oils with furfural and phenol and removal of mercaptans from gasoline.

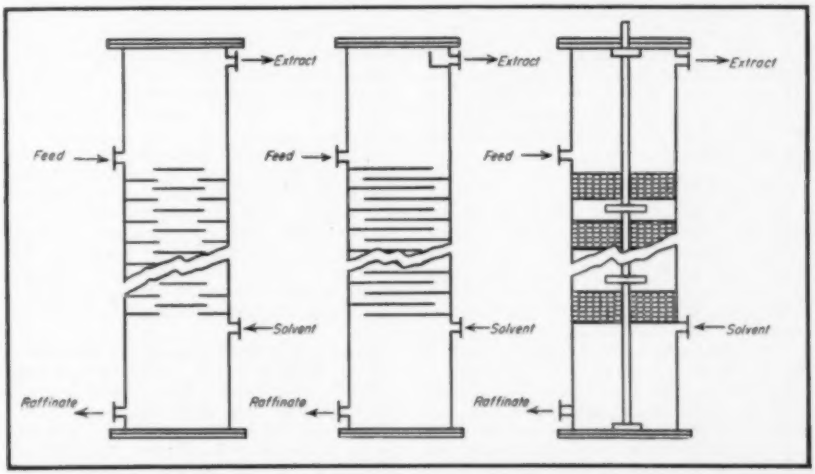
### BAFFLE COLUMNS

This type of extractor consists of a tower fitted with horizontal baffles over which the dispersed liquid phase flows, exposing considerable surface to the continuous phase. The baffles are so arranged that liquid flows across the baffle and then cascades to the one below. There are two general types in use—disk-and-doughnut and side-to-side or center-to-side baffle trays.

*Principal types*

Disk-and-doughnut baffles consist of alternate annular rings and centrally supported disks, which in most cases overlap somewhat. This construction permits the use of rotating scrapers to remove solids from the trays. The side-to-side and center-to-side baffle arrangements make use of segmented or slotted circular plates. Plate spacing is usually 4 to 6 in.

These columns are of simple construction with no small holes to clog up or be enlarged by corrosion. In the case of the disk-and-doughnut type it is possible to clean out deposited solids reasonably well, but the other baffle types




EXTRACTION COLUMNS: disk-and-doughnut, left; side-to-side, center; York-Scheibel, right.

*Avoid emulsification*

are difficult to clean. Because of the smooth flow of liquid through the column it is possible to handle materials that emulsify easily and which would be difficult to handle in extractors having better mixing. The chief disadvantage is, however, the very low efficiency, 0.05 to 0.1 theoretical stages per baffle.

These extractors find use in acetic acid recovery and similar applications where there may be emulsification or solids deposition.

### PULSATING EXTRACTORS

Since the main objective of any of the previously mentioned extraction devices is to obtain intimate contact between two liquid phases, particularly in countercurrent flow, it should be profitable to work on the basic problem of internal turbulence.

*Added turbulence*

Pulsating columns achieve internal turbulence by the simple expedient of having a reciprocating motion imparted simultaneously to both liquid phases. Experimental packed columns operating with 30 to 80 pulsations per min. at an amplitude of ¼ in. have demonstrated their equality to ordinary columns three to five times as high. There is evidence, however, that emulsification problems will limit the effective use of this type of extraction device.

### YORK-SCHEIBEL COLUMN

*Vertical mixer-settler*

Basically the York-Scheibel column is a series of mixer-settler units stacked vertically so that they function as a continuous countercurrent unit. The unit takes the form of a column in which there are mixing sections separated by packed separating sections. Agitation is accomplished by paddle agitators driven from a common vertical shaft. The packed sections are packed with wire mesh; they act primarily to coalesce and separate phases but also accomplish some extraction because of the countercurrent movement of liquids through the mesh. This explains why a mixer-settler section can be equivalent to more than one theoretical stage in some cases.

In commercial size columns it is possible to build a mixer-settler unit that is from 1 to 2 ft. high. Since the efficiency of a unit is 80 percent to better than 100 percent, a York-Scheibel column would have an H.E.T.S. in the range of 1 to 2 ft. This means that a large number of stages can be incorporated in a reasonable height of column.

### PODBIELNIAK EXTRACTOR

*Uses centrifugal force*

Basically this machine consists of a long perforated ribbon coiled into a spiral which, with a casing, forms an extended narrow rectangular passage for liquids for the entire length of the spiral. The assembly rotates at 2,000 to 5,000 rpm., developing a centrifugal force of several thousand times gravity.

The light liquid is fed through the shaft to the outside of the spiral; the heavy liquid is fed in the same way to the center of the spiral. Pressures of 50 to 200 psi. at the inlets are required to overcome the back-pressure developed by the centrifugal force. Both extract and raffinate also flow out through passages in the shaft.

Because of centrifugal force, the heavy liquid will move outward along the outside face of the spiral passage, while the light liquid is forced to flow countercurrent to it along the inside face. Liquids will also jet through the perforations to spray into the opposite phase in the adjacent passage.

*Rapid mass transfer*

With the rapid movement of the liquids through the narrow passage very high shear is produced at the interface of the liquids, as well as in the main body of each phase. This effect, along with the spraying of the liquids, results in very high rates of mass transfer between phases. The centrifugal force acts to separate the phases continually so that true countercurrent action is obtained.

The Podbielniak extractor is particularly well adapted to handle materials that emulsify, materials of extremely small density difference, solids in either phase, and materials which are unstable under extraction conditions.

Maintenance costs are said to be low, usually lower than the pumps feeding the units. The mechanical shaft seals are quite reliable, and when necessary they can be replaced in 15 min. Units designed to handle dirty liquids or suspended solids can be flushed in less than ½ hr. through special cleanout devices.

The commercial machines all use a 27-in. rotor, which allows the construction of a compact unit. In certain applications this extractor would be equal in capacity to a tower 8 ft. in diameter.

*Up to 20 stages*

Two different models are available—a low-stage (3 to 5) and a high-stage (8 to 20). The low-stage model has a capacity range to 20,000 gal. per hr., the other to 5,000 gal. per hr. The actual time of passage through the machine is a matter of a few seconds.

The first and largest applications have been in the pharmaceutical industry, largely because of the low holdup and versatility. Installations are now being made in the organic chemicals and petroleum industries.

### LUWESTA EXTRACTOR

*Three stages in one unit*

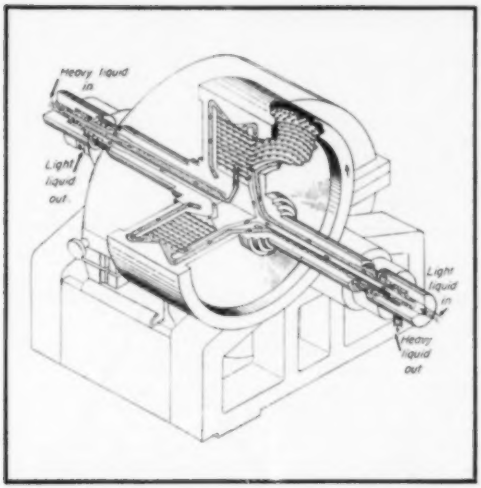
This machine is fundamentally a cream-separator type of centrifugal in which is incorporated a spray-disk mixing device. Three stages of mixing and separating are built into a single bowl 21 in. in diameter with an over-all height of 55 in.

One feature of the Luwesta extractor is its ability to handle a feed containing solids. The solids collect at the periphery of the bowl and can be removed by disassembly of the extractor. The cleaning operation requires about 1 hr. In a typical installation operating on the recovery of acetic acid from the manufacture of cellulose by extraction with ethyl acetate, the extractor required cleaning only once every 48 hr.

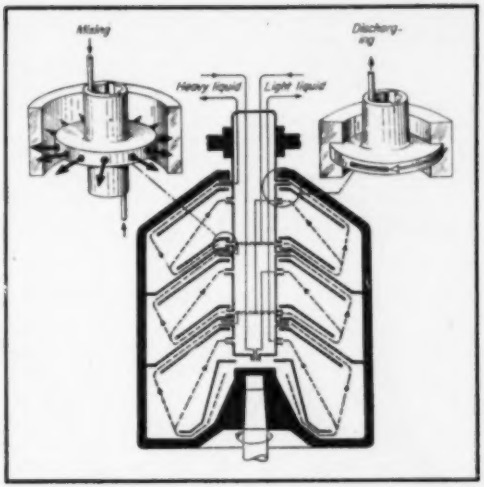
*Low holdup*

Because of its low holdup relative to capacity and its ability to handle emulsions, it is well suited to solvent extraction of penicillin and other antibiotics from their cultures.

This machine has a capacity of 1,300 gal. per hr. maximum at 3,800 rpm. It has a bowl volume of 18.5 gal. and a sludge space of 7.5 gal.




PODBIELNIAK extractor uses a perforated spiral ribbon.




LUWESTA extractor combines three stages in one machine.

Single-stage machines are also made under the trade name Centri-Westa. These can be connected to give any type of multiple-stage continuous extraction system desired, cocurrent or countercurrent. The largest one operates at 3,700 rpm. with a capacity of 500 to 2,000 gal. per hr. The bowl volume is 17.2 gal. and the sludge space 5.6 gal.

## How to Select a Suitable Extraction Solvent

*Types of systems*

There are only a few types of liquid systems actually used in liquid-liquid extraction processes. Three general types are worthy of consideration here: (1) A solute distributed between two essentially immiscible solvents; (2) a ternary system with one partially immiscible pair, the other pairs completely miscible; (3) a ternary system with two partially immiscible pairs and one pair completely miscible.

In cases where mixed solvents are used it may not be possible to simplify the analysis to that of a ternary system. Such a system may be difficult to analyze and usually requires a rather thorough investigation to indicate whether it is a useful system for a contemplated extraction. Discussion of such special cases is outside the scope of this report.

Extraction systems are loosely classified as the first type even when the solvents are miscible in each other up to a maximum of several percent. From the standpoint of rough design calculations and appraisal of the system they may be considered immiscible. However, for solvent recovery this miscibility will be an important consideration.

In a favorable system a high distribution coefficient for the solute exists between the extract phase and the raffinate phase.

*Triangular diagrams*

The second and third types of extraction systems are best shown by use of triangular diagrams, which show the phase relations of the three components. Solubility curves on these diagrams indicate points at which a change in over-all composition produces a change in the number of liquid phases. Hence, a mixture in the two-phase region splits into phases represented in composition by the ends of a tie line through the over-all composition point.

It must be remembered, when working with such systems, that the solubility curves vary greatly with temperature.

Since the solvent is always recovered, the analysis of an extraction system is best made by considering the solutions after solvent removal (solvent-free basis). On a three-coordinate diagram this is easily managed by carrying the composition of each layer on the diagram back along a line running from the solvent apex through the composition point to the base opposite the solvent apex. This then represents the enrichment (extract) and depletion (raffinate) obtained.

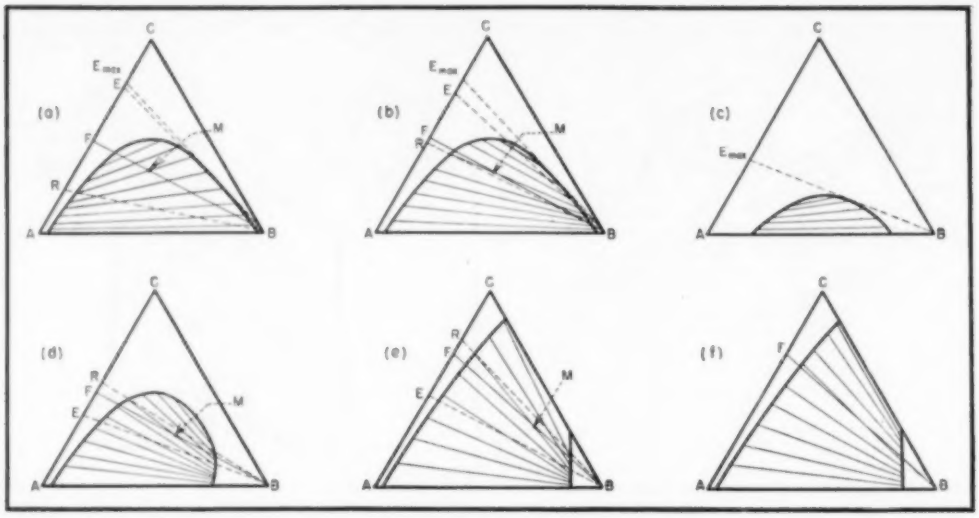
*What to look for*

Let us now consider a system with one partially immiscible pair and see what is required of it to make a good extraction system. In the diagrams, *C* is the solute, and it will be assumed that the solution to be extracted is a mixture of *A* and *C*, represented by *F*.

The questions now are whether *B* is a good solvent and whether this is a practical extraction system. Two things must be considered—the maximum possible enrichment of solute in the extract and the number of stages required to effect the extraction.

*Maximum enrichment*

The maximum enrichment of solute *C* can be obtained by drawing a tangent to the solubility curve from the solvent apex *B*. The point of tangency is the point of highest ratio of *C* to *A* on the solubility curve. This ratio may not be reached easily in a practical process, but it does represent the maximum enrichment obtainable using this extraction system. It




**SOLUBILITY** and tie-line data on triangular diagrams permit ready analysis of ternary liquid systems.

should be easy to see that a curve of the type shown in (a) is much to be preferred to that shown in (c).

***Study the tie lines*** The other consideration involves the slope of the tie lines. Although most analyses are made on the basis of countercurrent extraction, these systems can be judged qualitatively by considering only a single contact and separation stage. Here we find in general that the larger the angle between the tie lines and a line drawn from the solvent apex through the two-phase region, the greater is the separation of extract and raffinate.

This is illustrated by a consideration of the over-all composition *M* (feed plus solvent) in (a), (b) and (d). The solvent-free extract and raffinate are shown by the points *E* and *R* extended to the side of the triangle *AC*. In (d) we have the extreme case in which the tie lines have such an unfavorable slope that *B* is a better solvent for *A* than *C*.

A system consisting of two partially immiscible pairs is shown in (e) and (f). In such a system *B* is the solvent for either *A* or *C*, depending on the slopes of the tie lines. All enrichments of *A* or *C* are theoretically possible in this system.

The system in (e) gives reasonable enrichment of *A* per stage. In (f) the angle between the tie lines and a line drawn from the solvent apex through the two-phase region is very small, and it is a much less satisfactory system.

***Complex systems*** Other types of systems can be analyzed qualitatively using similar methods. There exist, however, many unusual liquid systems whose analyses require a more exact and quantitative approach. It should be fully understood that countercurrent flow, ratio of feed to solvent, use of reflux, all have a great influence on the exact way a liquid-liquid extraction will function. Hence, the final analysis must be made by calculating the number of theoretical stages needed for a particular process. Such methods are demonstrated in detail by Perry[3] and Treybal.[4]

***Don't forget costs*** In choosing an extraction solvent a number of factors in addition to selectivity must be considered. High recovery of solvents is necessary for economical operation of an extraction process. Cost of solvent is important in terms of makeup for losses as well as first cost. Ease of separation requires reasonable viscosity, reasonable density difference of phases, and an interfacial tension sufficiently high to discourage emulsion formation. Other considerations include such factors as toxicity, flammability, vapor pressure and corrosiveness.

### GETTING THE SOLUBILITY DATA

It is a fortunate circumstance when the data for a desired specific ternary liquid system happen to be in the published literature. This is quite understandable when we consider the number of possible systems, and it seems even more reasonable when we remember that such systems may be used over a considerable temperature range as well. Because it is very probable that a proposed extraction will require an experimentally determined phase diagram, here is a brief description of the usual method of determining such a diagram in the laboratory.

Two things must be determined—the solubility curve and the tie lines relating the points on the solubility curve. The usual procedure is to obtain this information from two separate sets of experiments.

***Titrate to cloud point*** Solubility determination by the cloud point method involves making up known mixtures of two components and titrating at constant temperature with the third component until a cloudy solution is obtained. This cloud point indicates the formation of a second liquid phase. By the proper choice of starting mixtures

and titrating components complete solubility curves can be defined.

It is also possible to determine easily measured properties of these solutions, which lie on the solubility curve, such as density, refractive index, or chemical analysis for one component. The value of such a property is usually unique for each point on the solubility curve. In cases where there are two points having the same value it is usually possible to tell which is the correct one.

The determination of the tie lines then consists of making up mixtures that will split into two equilibrium phases. These are analyzed for composition and located on the solubility curve. These two points are the ends of a particular tie line. *Locating tie lines*

Usually the determination of a satisfactory diagram requires only one or two days of laboratory work. With pressurized, corrosive, or unstable systems the determination is more difficult. This preliminary work is necessary, however, before you can adequately engineer a commercial extraction process.

## Extraction Vs. Other Chemical Engineering Separation Methods

How does liquid-liquid extraction compare with other methods of separation used by the chemical engineer? Table II shows where the various unit operations which involve phase changes or transfers between phases can or are being used, with appropriate examples.

*Choice of method* Frequently the choice of extraction as the desired separation method is so obvious that one hardly thinks of it as an extraction; for example, simple batch washing to remove small amounts of impurities. In other cases the answer is not at all simple.

A difficult selection to make is from among the operations of simple fractional distillation or stripping, extractive or azeotropic distillation, or liquid-liquid extraction. The following discussion considers these three cases:

*Ordinary distillation* 1. Simple fractional distillation and stripping depend upon a difference in volatility between the desired fractions. If this difference is great, then the distillation process becomes easy, and it is the obvious choice. Furthermore, distillation lends itself to the possibility of removing reasonably pure side streams from a given column. One column thereby does the work of several, although supplementary stripping operations may be used in some cases to purify the side-stream cuts.

As the relative volatilities of the desired fractions more closely approach each other the distillation column must have more plates and operate with an increasing reflux ratio. This is in the direction of higher investment and operating costs. A column with as many as 100 or 120 plates is usually built in two sections; piping arrangements are complicated and reflux must be pumped between the sections.

*Azeotropic distillation* 2. When the problem of separation by ordinary distillation is too difficult, and in the case of azeotrope formation is impossible, introduction of a third component may selectively influence the volatilities and thereby, in effect, increase their relative volatilities. If the third component is volatile and essentially goes overhead, the process is known as azeotropic distillation. On the other hand if most of it is

**Table II—Where Various Non-Mechanical Separation Methods Are Used**

| | Dissolved Solids | | Liquid Solutions | | | |
|---|---|---|---|---|---|---|
| Method | Single | Two or More | Volatile Fraction Minor | Volatile Fraction Major | Close-Boiling Fractions | Heat-Sensitive Materials |
| Crystallization | $Na_2SO_4 \cdot 10\ H_2O$ | KCl from NaCl | ——— | ——— | ——— | Quinine from alkaloids |
| Evaporation | Sugar; NaCl | NaCl from NaOH | Concentration of spent $H_2SO_4$; butanol from dibutyl phthalate | Flashing of propane from propane-fat extract | ——— | Evaporated milk; freeze drying; fruit juice concentration |
| Adsorption | Antibiotics | Decolorization of sugar | ——— | Drying of benzene, gasoline, etc., with silica gel and alumina gel | Recovery of aromatics from hydrocarbons | Antibiotics |
| Ion exchange | ——— | Separation of heavy metals; water softening | ——— | ——— | ——— | ——— |
| Thermal diffusion | ——— | ——— | ——— | ——— | Tall oil; separation of high-octane gasoline components | ——— |
| Ordinary distillation | ——— | ——— | Stabilization of gasoline; recovery of organic solvents; stripping | Gasoline rerunning | Heavy water | Molecular distillation; vitamins |
| Azeotropic or extractive distillation | ——— | ——— | Absolute alcohol using trichlorethylene or ether | ——— | Toluene from hydroformate; butadiene recovery | ——— |
| Liquid-liquid extraction | Phenol from water using benzene | NaCl from NaOH using $NH_3$; chromate from vanadate salts using ketones | Aniline from water using nitrobenzene | Acetic acid from water | Lube oil refining | Antibiotics and vitamins |



*More about the authors*

**The authors of this report, shown above in their Cornell laboratory (Von Berg, left, Wiegandt, right), modestly omitted reference from their manuscript to their own work on the pulsating extraction column mentioned on p. 196.**

**They are working here with a 1¼-in. column packed with ¼-in. Raschig rings, using the system, methyl isobutyl ketone-acetic acid-water. Pulsations of various frequencies and amplitudes are given the liquid by an automobile fuel pump.**

**For control purposes, they run parallel tests without pulsation. Under typical non-pulsating conditions, H.E.T.S. is 7.8 in. With a pulse rate of 74 cycles per min. and a ¼-in. amplitude, H.E.T.S. is reduced to 1.6 in.**

cal. Extraction with benzene produces a more concentrated phenol solution for which the separation by distillation can be economically justified.

*The volatile fraction is a minor part of the liquid*—Distillation in this case is the most common and usually the best choice. Even with a high reflux ratio the heat load will not be excessive. The addition of a third component would be considered only in the event that the composition reaches a pinch region, as with ethanol and water.

*Exception to the rule*

In unusual cases an extraction might be the most economical. In the example given, extraction with nitrobenzene is practical for the recovery of aniline (by the Bechamp reduction of nitrobenzene) which remains dissolved in water after primary separation. Here the aniline and nitrobenzene are not subsequently separated and nitrobenzene is highly insoluble in water.

*The residual fraction is a minor part of the liquid*—Distillation of a large quantity of material either to discharge or recover a small amount of residue requires a large heat input. Whether or not the solvent recovery operation means a sufficient saving in energy requirements to justify the recovery equipment requires independent analysis. In the case of dilute acetic acid solutions obtained from cellulose acetate precipitation following acetylation, there is little question that it would be desirable to avoid the removal of water by fractional distillation.

*Close-boiling materials*—It may be desired to separate a mixture of materials boiling so close together that distillation is not practical, or perhaps impossible. A mixture of this kind may be actually produced by a previous distillation step. In addition to extraction, azeotropic and extractive distillation should also be seriously considered in this case.

*Solvent sorts out molecules*

The correct solvent in an extraction process will recognize differences in the kinds of molecules and permit separations of an entirely different character than ordinary distillation. The refining of lubricating oil is an outstanding example. Even today little is known about which specific molecules are present, but it is known that solvents can extract an undesirable fraction and leave a much improved product.

*Extraction vs. high vacuum*

*Heat-sensitive substances*—In some cases a product will be damaged if elevated temperature is applied. Many pharmaceuticals can be included for this reason, as well as for reasons of low vapor pressure. In some instances high vacuum will allow fractionation, for example, vitamin concentration by molecular distillation. Extractions are carried out at temperatures which correspond to the best operating conditions, and for heat-sensitive substances a system is selected that permits mild conditions.

eliminated with the bottoms, it is called extractive distillation.

Common examples include the recovery of absolute alcohol using benzene, trichloroethylene, or ether as azeotropic agents, and the recovery of toluene from hydroforming using furfural as an extractive agent. Resorting to these methods of distillation entails much added expense. It is necessary to recover the third component by supplementary recovery operations which may be more complex than the main separation step itself.

*Liquid-liquid extraction*

3. Another alternative is liquid-liquid extraction. The separation problems are considered according to the classification in the table.

*Solutions of two or more dissolved solids*—The requirement for volatilization immediately rules out the distillation methods, but extraction is feasible for a number of inorganic separations. Elimination of NaCl from 50 percent caustic solution is done commercially by $NH_3$ extraction.

*Extraction saves fuel*

*Solutions of a single solid*—The use of extraction here is entirely dependent on the possibility of saving fuel. Phenol is ordinarily recovered from water by distillation and proper handling of the azeotropes. However, in very dilute concentrations distillation is uneconomi-


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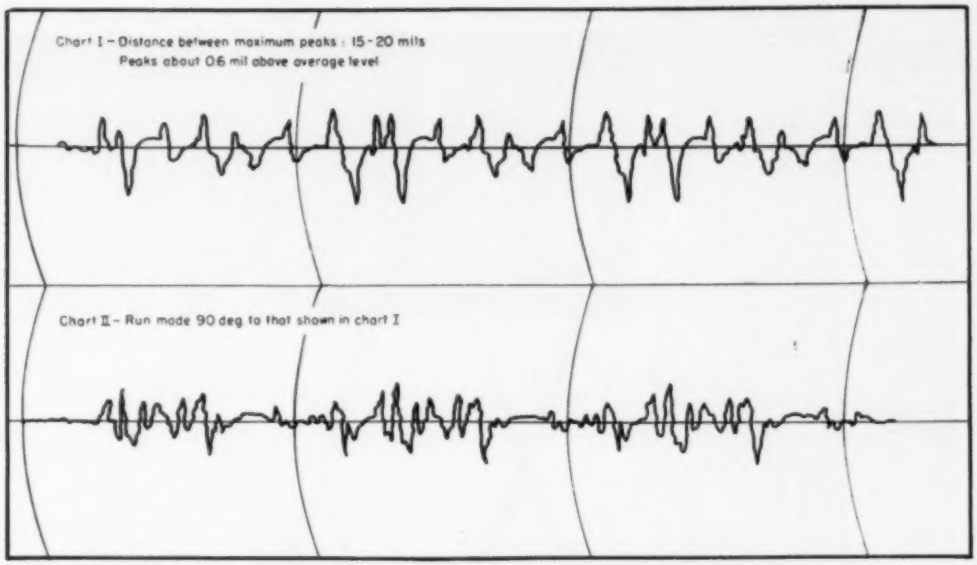



Fig. 1—Profile (facsimile) of a grit-blasted surface used in establishing the coating thickness-profile depth ratio.

# New Standard for Coating Thickness

**Coating thickness should be at least three times the profile depth—another addition to the still-limited but steadily-increasing fund of knowledge about intelligent application.**

**MAX KRONSTEIN**

Coating thickness should be three times the profile depth to resist moisture penetration. This is the conclusion reached after measuring the profile of grit-blasted steel surfaces and determining the effect of various thicknesses of organic coatings on moisture penetration. The electrographic printing method[1] was used to detect moisture penetration and under-film spreading of moisture.

### STUDY OF THE PROFILE

The profile was studied by using a Brush Development Co. Model BL-103 surface analyzer. This instrument explores and automatically charts the surface profile. This is accomplished by the use of a motor driven pickup arm, a calibrating amplifier and a direct inking oscillograph.

The crystal in the pickup is attached to a diamond stylus located in the extreme tip of the pickup arm. As the pickup moves back and forth over the test surface through a 10-sec. cycle, the vertical motion of the stylus in its trace over the surface irregularities flexes or bends the crystal. Upon being bent, the crystal generates a voltage, the polarity of which depends upon the direction of the stylus movement. This voltage is then amplified sufficiently to actuate the pen motor located in the direct inking oscillograph. The pen motor drives the inking pen over a moving paper chart according to the direction and magnitude of movement of the pickup stylus.

In applying this instrument to the surface of a factory grit-blasted panel of transformer steel, charts corresponding to those in Fig. 1 were obtained. Running the test in a direction of 90 deg. to the first test (Chart I) yielded the results shown in Chart II. For these tests, the instrument was run at a speed of 5 mm. per sec. To avoid considerable roughness of the grit-blasted surfaces throwing the pen off the chart, the sensitivity of the instrument was modified by using an attenuator.

Since the surface preparation of the test panel by grit-blasting did not add anything to the steel surface, the peaks on these charts are not elevations above the initial surface but are remaining points of the old surface. The middle line on these charts is the average level produced by the grit blast.

Chart I shows that the peaks, in the case of the panel which was tested, are about 0.6 mil above the average level. The lower chart is in good agreement.

Chart I further shows that there is considerable difference in the elevation of the various peaks, and between the depth produced by the various grits. The profile range varies from

MAX KRONSTEIN *is a research associate, College of Engineering, New York University. He is the author of numerous articles about protective coatings, and an active member of the Surface Preparation Committee, National Ass'n. of Corrosion Engineers.*

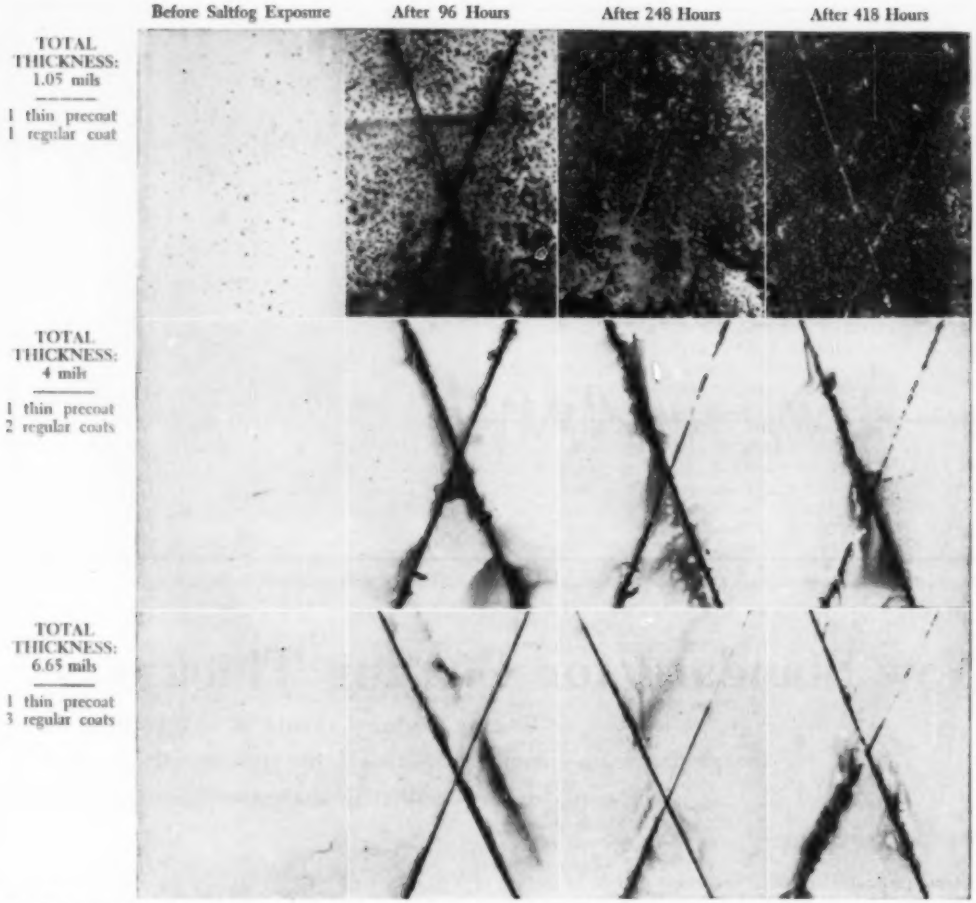



Fig. 2—Improvement in resistance to moisture penetration with increasing thickness using coaltar paint. Other organic coating systems that are generally suitable for outdoor application on steel gave similar results. Electrographic printing was used.

0.8 to 1.7 mil, with a distance between the maximum peaks of about 15 to 20 mils.

Chart II shows that the valleys of the profile are not as regular as Chart I indicates. It shows that there are deep valleys with smaller intermediate ones also.

The profile analyzer has an attachment for giving a quick indication of average surface roughness. This consists essentially of a rectifier circuit and highly damped microammeter. This instrument does not give the true RMS value of complex surface roughness, but rather indicates an average value of the surface condition. In other words, it does not give the actual profile depth at any one point of the test area, but an average roughness. In the case of a highly irregular surface, such as the grit-blasted panel under consideration, the RMS reading differs widely from the actual profile range. For the surface tested in Chart I, the RMS figure was 0.2 mil. Tested at 90 deg., the RMS figure was 0.15 mil.

In view of the considerable difference between the average roughness of the surface under question and the total profile range as indicated on the charts, it seems well to consider whether for suitable corrosion protection the coating film-thickness can be based on the average roughness or whether it must be based on the actual profile range. Further tests made on the grit-blasted panels have indicated that the latter is the case, and that unsatisfactorily protected peak positions quickly turn into centers of failure for the protective system.

### EVALUATION OF A COMPLETED COATING SYSTEM

Freshly grit-blasted panels were dip-coated and air-dried for 48 hr. Where several coats were applied, 24 hr. was allowed between coats. The panels were then aged for 12 hr. at 50 deg. C., before being tested.

The film-thickness of the finished coatings was determined with the Magne-Gage (American Instrument Co.). This instrument measures the distance between a calibrated magnet, which is placed on the coating surface, and the steel base underneath. Since the width of the magnet is greater than the distance between the peaks of the grit-blasted panel, it may be assumed that the instrument readings represent distance from or film-thickness over

the peak areas and that the film thickness of the paint in the profile valleys might not be measured by this instrument.

If the paint is anchored in the profile, the underside of the paint film approaches a reverse picture of the tested profile. This again causes considerable variation in the thickness of the coating films, with greater film-thickness in the valleys of the profile and thin spots on the peaks of the profile. It is evident that too great a variation in these figures, especially in the case of too thin a film over the peaks, can cause failure on these points quickly.

### TESTING BY ELECTROGRAPHIC PRINTING

Electrographic printing[1] is a method whereby points and areas of moisture penetration through a film are accurately shown in permanent record form. It has been used with good success in the N. Y. U. Paint Research Laboratories in the evaluation and investigation of organic coating systems.

In the present application it is possible to locate in the prints the position of the sand blast peaks under a too thin paint film application and to compare them with the peaks in the profile charts. In these tests prints were made before saltfog exposure of the coated panels as well as at stated times after exposure.

Fig. 2 shows electrographic prints made on three grit-blasted panels of transformer steel, coated in three different film thicknesses. Here, prints were made before salt-fog exposure and at stated time intervals of exposure in the salt-fog cabinet. The film thickness of the thinnest coating was 1.05 mil, measured by the Magne-Gage. The highest peaks of the profile are shown in the print before salt-fog exposure and are quite in agreement with the profile chart shown in Fig. 1. After 96 hr. salt-fog exposure, the print shows the location of the lower profile peaks which had a somewhat heavier paint film. The print made after 248 hr. salt-fog exposure shows corrosion over the entire paint surface, with the peak point already turning into the progressed non-ionizable rust form,[2] which prints white instead of blue as with the early form.

The middle row of prints in the same figure shows the effect of applying another coat of the same paint whereby the film-thickness was 4 mils measured by the Magne-Gage, or close to three times the deepest profile depth. Here, the prints do not show the peaks of the profile any more, even after 418 hr. salt-fog exposure. The print shows, however, some spreading of moisture from the test cross.

NOTE: *The sub-committee on surface preparation, National Association of Corrosion Engineers, has recently made the recommendation that the thickness of an organic film be at least three times the profile depth of the steel, the same relationship as is developed in this article. This recommendation refers of course to well-developed profiles. In making this recommendation the sub-committee had the benefit of extensive experimental work by the Dravo Corp., Pittsburgh, under A. J. Liebman.*

*See "Key to Savings in Painting Costs" by Robert R. Pierce, p. 149 of the May, 1952 issue of Chemical Engineering for reasons why minimum thickness of coatings should be 5 mils.* —EDITOR.

The bottom row in Fig. 2 shows that a further increase in film-thickness to 6.5 mil or more than four times the deepest profile depth also gives a complete coverage of the peak areas. Here the heavier film has also retarded the spreading of moisture from the test cross. In the panels shown in the middle and bottom rows the grit-blast structure became visible along the test cross after a considerable length of salt-fog exposure.

This test can be used for quickly determining the required minimum film-thickness for a given steel surface. Salt-fog exposure is not too severe a test in these evaluations, since results obtained in the combined salt-fog exposure and electrographic printing tests after a very short test period are confirmed in tests made over a longer period of time. For example, one panel has been flow-coated with a lead chromate primer and two coats of gray paint. The Magne-Gage showed a film thickness of 2.1 mil. Prints of the freshly made and cured paint coating showed very few peak areas. But after leaving the panel exposed in the laboratory atmosphere for three months, the electrographic prints show the complete steel profile in the form of points of developing corrosion.

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## CYCLONES

(*Continued from page 173*)

sharper than obtained by gravity sedimentation, but it can also be operated to give much less sharp separations.

Sharp classification is not always desired. Although it has been shown that cyclones are classifiers rather than thickeners, they have been used as substitutes for thickeners where fines can be tolerated in the overflow. In fact, this was one of the original uses for which they were developed by the Dutch State Mines. When substituting for a thickener, it is desirable to collect just as many of the solids as possible in the underflow. Under such conditions the cyclone would be operated to be a poor classifier, throwing critical sizes as much as possible into the underflow rather than into the overflow. Cyclones for this job will normally be as small in diameter as is consistent with operating convenience, and will have relatively small ports. They will be operated at high pressures, and with as dilute underflows as possible processwise.

### OPERATING REQUIREMENTS

Interchangeable feed entrance shims and vortex finders give the unit considerable flexibility. Without this feature it would not be feasible to adjust cyclone behavior for optimum process performance, or to make the changes in mesh of separation dictated from time to time by process considerations. However, once the unit is set up with the selected fittings, it is essentially a constant flow machine. Means must be provided to maintain the feed flow required by the machine under the chosen conditions. Suitable means comprise surge tanks, controlled additions of water where permissible, and recirculation of machine overflow.

Control of the apex valve is often necessary. Small fluctuations in the amount of underflow solids to be discharged will not greatly change the percent solids in the underflow, because in this respect cyclones have a limited self-regulating tendency. To accommodate large changes, if a constant and high percent solids in the underflow or a sharp classification is desired, it is necessary to control the apex valve diameter. Where the changes in feed slurry composition are gradual, manual control of the apex valve will often suffice. To handle rapidly changing conditions, an automatic apex control system is available.

### REFERENCES


1. *D. A. Dahlstrom:* Cyclone Operating Factors and Capacities on Coal and Refuse Slurries. *Trans. AIME* (1949) 184, p. 331-334; *Mining Engineering* (Sept. 1949) TP2633P.

# Editorial Viewpoints

## How Much Job-Hopping?

Throughout the country, engineers seem to be recklessly job-hopping. Employers of engineers are sometimes behaving like city slickers at a country auction when bidding for employees.

Now we're not going to come right out and say that we in the chemical industry are "Simon Pure" but it does seem to us that there's every evidence of level-headed behavior. Here's why we think so:

The Wage Stabilization Board said last March that job-hopping and pirating of engineers constituted a pretty serious problem in the engineering field. There was even some talk about the unsavory "flesh peddling" where a consulting outfit hires engineers on contract at $400 a month, then sells their services to a company at $600.

So we decided to take our own look at the chemical side of the fence.

We now publish the results of our survey (see p. 162). All in all, it points up a pretty good record of stability of employment and close harmony between employer and employee.

In a milieu where there aren't enough engineers to go around and almost anybody can get a higher salary, one chemical personnel director after another was able to make such statements as:

"Out of some 300-450 engineers we have lost only eight during the last one and one-half years."

"During the last two years, we have lost only nine engineers under circumstances which might be called 'induced by competitive employers.'"

And so it went throughout the survey. We think it adds up to a clean bill of health under pretty tough circumstances.

## A Good Start by Delaney

The House of Representatives Select Committee investigating chemicals in foods, cosmetics, pesticides, and fertilizers is now reporting its conclusions from the two-year investigation. The report is appearing in four or five parts, each dealing with a certain phase of the broad inquiry. The first part deals with fertilizers.

We have not seen the rest of the report, but if it is as constructive a document as Part 1, all of industry will be much pleased.

In this first part the Committee, after a brief review of the relation of fertilizers to foods and health, concludes that there is no need for new federal legislation. But it does point out the need for further technical investigations. This conclusion will be commended by many, perhaps all. And there seems little doubt that the Department of Agriculture will be encouraged to do a more fundamental job on the relation of dietetic value of food to both the soil on which it is grown and the fertilizers used. Much is already known, but more basic knowledge of this phase of chemical agronomy is desirable.

## International Commodity Woes

The control of scarce materials for American industry has called for certain international controls. Defense officials achieve this through international materials control committees. Some benefits result. Many complications—and at least a few grave disadvantages—have also resulted.

Chemical engineers recognize already the case of sulphur as a major type of difficulty which has grown up. Sulphur is sold by American producers under a ceiling price of about $23 in the United States, and abroad under a ceiling of about $26. These figures are in great contrast with world prices: $40 and upward. Some black markets are reported to be getting close to $100 per ton.

Controlling the cost of sulphur is obviously a benefit to sulphur users. But almost equally obvious is the disadvantage to foreign producers who might try to open up new sulphur supplies if they were not discouraged by the low price which Uncle Sam's agents maintain over world business in sulphur.

In the first place, foreign sulphur users are demanding every pound of sulphur they can get from the United States before they will buy elsewhere.

Then, too, foreign users are so distressed in competition by the difference between $26 and $40 or more that they do not go out and encourage foreign production in greater amounts. This, of course, could in the end both lower world prices and reduce the burden on U. S. supplies.

Still another type of regulation hits chemical enterprise. Smart buyers can sometimes buy scarce materials abroad and process them into usable supplies for import.

For example: equipment makers can get copper abroad and make products from it which become parts of machinery and equipment in the United States. But these people learn that material so obtained is deducted from their quota under the controlled materials plan. Thus they have the higher cost of imported parts as a reward for their ingenuity in finding extra supplies of scarce material not available at home.

Frankly, we do not know the remedy for these

difficulties. But we do believe that American chemical business should seek new sources of scarce materials and then arrange to bring them to the United States to eke out otherwise inadequate supplies. This would naturally require special permits or arrangements that would get Washington's approval. Until officials do look with favor on aggressive ingenuity in getting scarce material for essential American business, we will not be able to take advantage of the availability of world-wanted dollars as fully as we might.

### Our Economist's Answer

Will we have shortages and controls for years to come? Here's the comment of the economist we most respect: By the end of this year, we'll have 12 percent more steel capacity, 75 percent more aluminum capacity, 22 percent more chemical capacity and 16 percent more total manufacturing capacity than we had at the end of 1950. Industrial production probably won't be more than 8 percent higher. There may still be shortages of cobalt and columbium in 1953. But we wouldn't want to bet on anything else being short —unless the international situation changes for the worse. Our guess, therefore, is that most controls will be out before the year is over.

### Research Survey: For What?

Defense's Research & Development Board has sent out questionnaires to survey present and desirable industrial research activities. The aim is to get information which may help in the planning of military research spending. Perhaps that purpose will be served.

But far more certain is the fact that there will be a lot of confusion in preparing the replies and in the interpretation of the results which may be compiled.

Recent government estimates point out that about $2.9 billion will be spent this year on "research and development" if military and civilian programs are carried out in full. More than half of the total will be money supplied by Uncle Sam. Industry, colleges, and endowment funds will provide the rest.

These amazing numbers become less appalling when one realizes that the totals include not only research and development as the terms are used typically by scientists and engineers, but also a great deal more. An unnamed—but very large—sum represents pilot plant work on products and processes and the design, construction and testing of prototypes of new equipment and devices. It is unfortunate that the three jobs of true research—process and product development, and prototype or pilot plant work—are thrown together so as to make a true appraisal of the resulting data very difficult.

Industrial research directors who get these questionnaires will have some trouble in filling them out. They may have less trouble if they remember the very broad meaning of "research and development" as used by RDB.

Regardless of the difficulty of answering the question, there will be some concern about the implications of this effort. It is obvious that RDB hopes to place new large research contracts with industry or with some institutions to expand its present programs. That effort may be desirable from the military point of view; but it certainly threatens to reduce the personnel and facilities available for the primary research objectives of industry.

Most chemical engineers will certainly hope that this survey program will not lead to promiscuous allocation of government funds in a way which will reduce the effectiveness and usefulness of industry's own efforts. Taxpayers, too, will hope that careful military planning will see to it that the maximum research value comes from each million dispersed from the U. S. Treasury.

### Economic Anomalies, Sure!

You might think—and for good reasons—that inflation and deflation are opposites, that both cannot exist at the same time. That was considered orthodox economics not so long ago.

But apparently it's not true just now. The crazy mixture of economic forces in industry, what with state and federal controls abroad and at home, is producing a dangerous confusion.

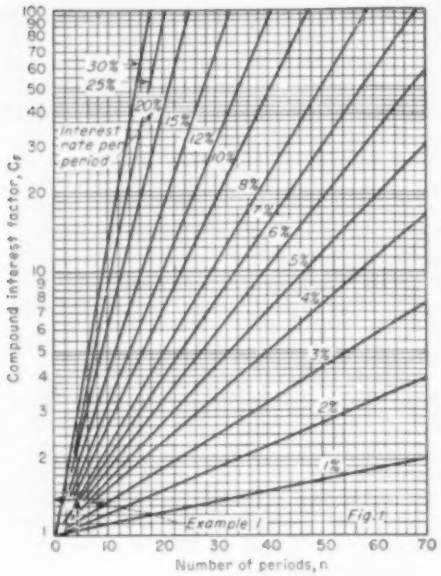
Both Washington and industry know that there are many soft points in the market. Most distressing, politically, has been the falling off of consumer purchases of goods like textiles and other soft commodities for home and personal use.

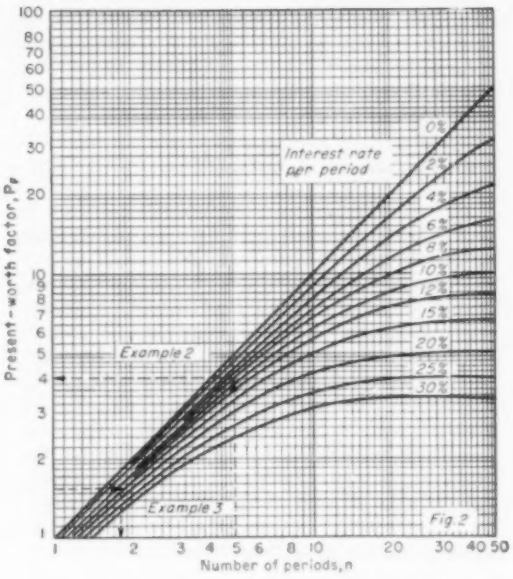
This has hit some chemical businesses pretty hard. Recently one important chemical manufacturer told us that close to 80 percent of the cut-back in his sales stems directly from the drop in the American housewife's demand for textiles.

Official Washington recently saw the straw in the wind of deflation and hence eliminated Regulation "W" which fixed down payments and rates of settlement for installment buying.

But at the same time, inflationary factors of stupendous force have come from huge defense spending and the big industrial programs that have been stimulated by our present tax laws. Both government and industry have thus been forcing goods and price inflation on the American people at the same time that deflationary threats of major magnitude were visible.

There is no clear way to tell whether inflation or deflation will come out on top in the net effect. But the chemical process industry must take account of both in planning its programs. It must prepare to meet almost insatiable demands for more goods. Simultaneously, it must watch such factors as labor costs, raw material prices, and the effect of price competition in many ultimate markets.




## Compound Interest Charts Speed Engineering Economics Studies

H. E. Schweyer, *Department of Chemical Engineering, University of Florida, Gainesville, Fla.*

★April Contest Prize Winner

In engineering cost studies it is often necessary to employ theoretical compound interest relations involving a time period and money at some interest rate. The purpose of this article is to present a simplified method for making these calculations and to illustrate the application.

Three compound interest relations often used are:

1. Future worth of a present sum as a single payment after $n$ periods:

$$S = P(1 + i)^n = PC_r \qquad (1)$$

2. Present worth of a series of $n$ uniform payments of an amount $R$:

$$P = R\left[\frac{(1 + i)^n - 1}{i(1 + i)^n}\right] = RP_r \qquad (2)$$

3. Periodic uniform payment for $n$ periods required to repay an original sum $P$, with interest:

$$R = P\left[\frac{i(1 + i)^n}{(1 + i)^n - 1}\right] = P/P_r \qquad (3)$$

where

$P$ is a present sum of money; $i$ is the interest rate as a fraction per period; $n$ is the number of periods; $S$ is a future sum; $R$ is a uniform periodic payment; $C_r$ is a compound interest factor equal to $(1 + i)^n$; and $P_r$ is a present-worth factor equal to $[(1 + i)^n - 1]/i(1 + i)^n$.

As shown above, all these equations may be expressed in terms of $C_r$ or $P_r$, which are compound interest terms for which the values may be found from tables in accounting or other handbooks. However, a large amount of this type of tabular information may be condensed by a graphical presentation which is sufficiently accurate for most engineering purposes. (But for best use the charts should be redrawn to larger scale.—Editor) Figs. 1 and 2 have been prepared for this purpose by evaluating $C_r$ and $P_r$ at various interest rates and for different time periods. Examples of the use of the charts are as follows:

*Example 1*—An engineer estimates that excavation costs for an equipment installation amount to $8,000. This field work is sufficient to take care of present plans although it is planned to double the equipment size in about five years. The contractor is willing to use his equipment on the plant site at present to double the excavation area for an additional $4,000. Assuming that excavating costs would be the same five years from now and the contractor would charge $8,000 for the job since his equipment would have to be brought in and set up again, is it economical to do all the excavating at the present time if money is considered to be worth 7 percent?

*Solution*—The problem may be restated as: What is the future worth five years from now at 7 percent interest of a present sum of $4,000? From Eq. (1) and Fig. 1, $S = 4{,}000\ (1.07)^5 = 4{,}000 \times 1.4 = \$5{,}600$. It appears economical to do the additional excavating at the present time since an investment of $4,000 today has a value five years from now of less than the $8,000 that would be required to do the job at the later date. The exact value of $C_r$ is 1.396 compared to 1.40 as read from the chart.

*Example 2*—A heat exchanger in a fermentation plant costs $1,800 but must be renewed every year because of corrosion. The exchanger manufacturer states that he can guarantee a five-year life for the exchanger by changing the materials. What is the maximum the engineer should pay

for such an exchanger if the fermentation company is earning 8 percent on its invested capital?

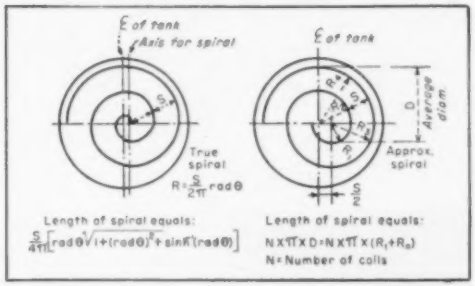
*Solution*—Alternately, this problem may be stated as: What is the present worth equivalent to a series of five annual $1,800 payments at 8 percent? From Eq. (2) and Fig. 2, $P = 1{,}800 \times 4.0 = \$7{,}200$. The exact value of the $P_r$ factor is 3.993.

The charts may also be used for trial and error problems where either the payout time or the interest rates are unknown.

*Example 3*—A proposed change in a hydrogenation process at a cost of $14,000 will result in annual savings of $9,200 when the depreciation allowance is included. If the company uses a 12 percent rate for payout computations, what is the payout time allowing for interest on the investment?

*Solution*—This is the reverse of Example 2 where the unknown in the economic equation is $n$ which can be determined from Eq. (2) which evaluates $P_r$ as $P_r = P/R = 14{,}000/9{,}200 = 1.523$. From Fig. 2 at $P_r = 1.523$ and an interest rate of 12 percent, the payout time is 1.80 years. An exact calculation gives 1.795 years.

The results obtained in these examples indicate that the charts provide a convenient means of estimating economic calculations with sufficient accuracy.



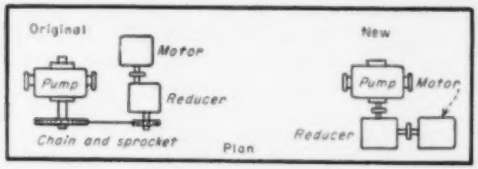

## Simple Design for Flat Steam Coils for Round Tanks

CHESMAN A. LEE, *Engineer, Darling & Co., Chicago, Ill.*

Quite often flat steam coils are used for the bottom of a round tank, wound approximately into the form of a spiral of Archimedes. It is desirable to have a quick and simple way of figuring the length of pipe in the coil, either for a certain spacing; or conversely, to figure the spacing of the coils for a given length. The exact formula is given in various handbooks, such as Marks'. As shown under the lefthand diagram above, this formula is fairly complex and something of a chore to handle. Furthermore, two calculations must be made since no practical coil starts at the mathematical origin.

The righthand spiral shown in the sketch is an approximation of the Archimedes spiral, composed entirely of semicircles. The true Archimedes spiral starts at the origin but the part actually of interest starts only at some later intersection with the axis. This curve has five intersections with the horizontal axis. For a steam coil, the most interesting property of the coil is the uniform spacing. The second, approximate spiral has the same uniform spacing and it also intersects the axis at the same points. It is built up by using two centers, one the center of the tank, the other displaced to the right a distance of $S/2$ where $S$ is the desired coil spacing. Then, by using the centers alternately with the radii $R_1$, $R_2$, $R_3$ and $R_4$ (each one $S/2$ longer than the one before), the approximate spiral is completed.

The length of any given number of coils produced this way can be expressed exactly as the sum of a fairly simple arithmetical series. However, the sum of this series equals $N \times \pi \times D$, where $N$ is the number of coils and $D$ is the average diameter or $R_1 + R_4$. Both coils come out to almost exactly the same length and the same simpler equation may be used for either. The answer will be "as close as makes no difference."




## Stroboscope Finds Pulsation Cause in Liquid Pumping

JOSEPH GIALANELLA, *Chief Engineer, Engineering Research Laboratory, Amersil Co., East Newark, N. J.*

The use of the stroboscope in some industrial applications offers a fast, simple, flexible and economical method for determining the magnitude of mechanical vibration frequencies and rapid cyclic occurrences in equipment. The stroboscope was employed to determine the origin of pulsations in liquids during pumping operation. In spinning threads the liquid must be pumped to the spinnerets free from pulsations to insure good quality. Other processes require similar conditions for satisfactory operation.

The origin of pulsations in a liquid may be determined by comparing the frequencies of all possible contributory

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★ May Contest Winner

"Designing a Temperature Control System for a Continuous Pipeline Reactor."

**A prize of $50 in cash will be awarded to Irving H. Cooper, project engineer, Chemical Research Department, Heyden Chemical Corp., Garfield, N. J. Mr. Cooper's article will appear in the July issue.**

$50 PRIZE FOR A GOOD IDEA—Until further notice the Editors of *Chemical Engineering* will award $50 cash each month to the author of the best short article received that month and accepted for publication in the Plant Notebook. Each month's winner will be announced the following month and published the second following month.

$100 ANNUAL PRIZE—at the end of each year the monthly winners will be rejudged to determine the year's best Plant Notebook article, which will then be awarded an additional $100 prize.

HOW TO ENTER CONTEST—Any reader of *Chemical Engineering*, other than a McGraw-Hill employee, may submit as many entries for this contest as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Articles which are acceptable but are not winners will be published at regular space rates, $10 minimum).

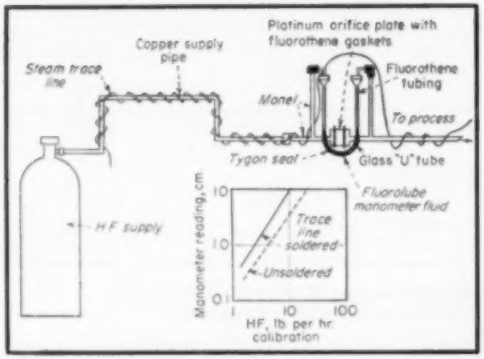
Articles may deal with plant or production "kinks" or novel means of presenting useful data, which will interest chemical engineers. Address Plant Notebook Editor, *Chemical Engineering*, 330 West 42nd St., New York 36, N. Y.

sources with the pulsation frequency in the liquid. Any frequency which matches that in the liquid is probably responsible for the pulsations, and can often be eliminated.

In a case of this type the frequency of the stroboscope was adjusted to correspond with the frequency of the pressure gage pointer and then with the drive chain. The pressure gage pointer frequency, of course, was equal to the pulsation frequency in the liquid. The following information was obtained at 100 rpm. of the pump: Chain drive frequency = 4,900 cycles/min.; pressure gage pointer frequency = 4,810 cycles/min.

If pulsations were due to the pump rotors, they would be in the order of some whole multiple of the number of teeth of the rotor, multiplied by the pump speed. For the pump tested at 100 rpm., the fundamental frequency would be 22 teeth times 100 rpm. or 2,200 cycles/min.

The results obtained indicated that the major pulsations in the liquid being pumped were caused by the chain drive and not by the pump rotors. Driving the pump directly through a worm gear reducer eliminated the pulsations in the liquid. The importance of a pump drive can not be overlooked in eliminating additional pulsations.




## A Flowmeter for Anhydrous HF

JOHN S. WILEY, *Iowa State College, Ames, Iowa*

Anhydrous hydrofluoric acid is usually something to be avoided. But with the recent emphasis on the material, a satisfactory method of metering the gas, especially in pilot plant operations, is of value. The purpose of this paper is to describe a method of metering anhydrous HF that has proved satisfactory in over three months of pilot plant work.

As can be seen above, the essentials of the metering system are a preheater, orifice and manometer. The preheater was necessary because HF gas associates in a dimeter, tetramer, and/or hexamer unless the temperature of the gas is kept above 90 deg. C.* The first calibrating run for the orifice was made with the steam trace lines merely wrapped around the HF-carrying line. The results are plotted as the dotted calibration line. Although the steam temperature was about 320 deg. F. the heat transfer was not enough to get straight line readings from the manometer. This indicated association. The soldering of the trace lines to the HF line resulted in enough heat being transferred to get the HF above 90 deg. C., although no temperature data were taken, with the resulting improvement of the performance. The solid line is the final calibration.

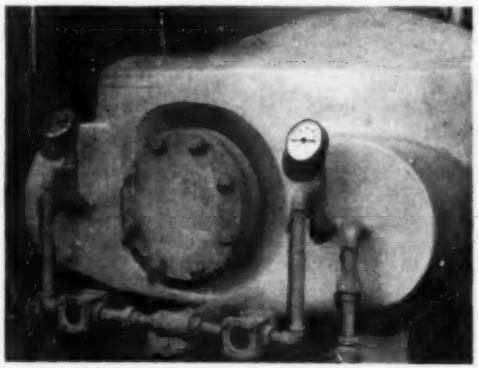
The orifice used was a platinum disk with an orifice diameter of $\frac{1}{4}$ in. The disk was bolted between flanged Monel pipe with fluorothene gaskets. In order to further seal the system the gaskets were coated with Lacoflex paint before assembling. In the event platinum would be undesirable, the fluorothene by itself would make a satisfactory orifice material.

Heart of the manometer system lies in the fluorothene manometer tubes and fluorolube manometer fluid. This combination of HF-resistant materials overcame previous difficulties of using oil-protected mercury or kerosene for a manometer fluid. A mercury manometer, protected with a drop of oil on the mercury surface, does not compare with a fluorolube manometer in maintenance costs while kerosene slowly absorbs HF with a resulting change in specific gravity. The only drawback with using fluorolube is its relatively high cost, but only a 100 cc. is needed for the manometer.

Since fluorothene was rather hard to bend in a sharp radius it was necessary to employ a glass U tube for the bottom of the manometer. This was satisfactory since the fluorolube did not let the HF reach the glass at any time. Also, it was necessary to keep the ambient temperature above 190 deg. C., the boiling point of anhydrous HF, to prevent condensation of the HF in the fluorothene pipes. As can be seen in the sketch, the pressure taps were on the top of the Monel pipe and a short vertical run was provided before the manometer was attached. This was to keep any trace of sulphates in the HF supply stream from dropping directly into the manometer as would happen if the manometer were attached to the underside of the pipe in the conventional manner.

The device has given good service and can be regulated down to flow rates of 1.70 lb. per hr. Thus relatively large cost and waiting time for delivery of commercial instruments for metering HF were avoided by use of this device.

* Simons, J. and Hildebrand, J. H. The density and molecular complexity of gaseous hydrogen fluoride, *J. Am. Chem. Soc.* **46**; 2183-2191, 1924.



## One Way to Help Prevent Damage to Insulation

As with the equipment it covers, insulation sometimes needs maintenance, but this is often neglected, as is pointed out by the Magnesia Insulation Manufacturers Assn. Insulated pipe lines most often need insulation repair around flanges and fittings. Equipment is most likely to suffer insulation damage around manholes or other openings where the edges are subject to hard contact and abrasion. Beveling insulation around a service opening, as in the view above, permits the cover bolts to be removed easily and thus helps to avoid damage.

# The corrosion resistance of glass *plus* the working strength of steel




## Pfaudler glass is locked to steel by chemical action

This photograph, a magnified cross-section of a glassed steel plate, reveals the powerful mechanical gripping that locks Pfaudler glass to steel. The roughening of the steel which makes this gripping possible is caused by a *chemical reaction* which takes place when Pfaudler glassed steel equipment is fired at high temperatures (1500°F.—1700°F.). A second, and equally important, result of this firing is the stresses which are built up within the glass itself as it cools after removal from the furnace. These stresses make the glass hard and tough.

Because it can be so durably bonded to steel, glass, with its *almost universal corrosion resistance*, is not limited to use in the laboratory alone. Today, glassed steel reactors in capacities up to 3500 gallons are commonplace and custom units as large as 8300 gallons have been constructed. These units are equipped with agitation, can be jacketed, and are supplemented by a complete line of glassed steel accessories.

Even at elevated temperatures and pressures, Pfaudler glassed steel is *resistant to all acids except hydrofluoric*. And now, with a new Pfaudler glass, it is possible to handle *alkaline* solutions up to pH 12 and up to 212°F.—with no reduction in acid resistance. Thus it is possible to perform a wide variety of reactions in a single vessel.

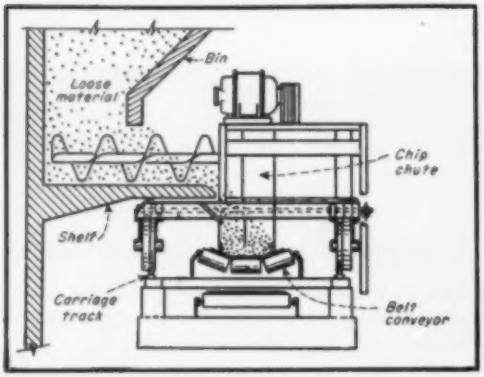
Whenever you have an equipment problem requiring *corrosion resistance, durability, and versatility*, as well as the economy which these features provide, look to glassed steel for the solution. Write for our general catalog today.

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TWIN-SCREW UNLOADER positioned under bin . . .



UNLOADS wood chips onto belt conveyor.

# Bin Discharge Flows Freely

**Traveling twin-screw unloader, used in combination with trouble-free bin design, provides continuous regulated free discharge from dry bulk storage.**

Continuous processes rely on an uninterrupted raw material flow from the stockpile. Frequently dry bulk materials stored in bins hang up or plug the discharge gate.

Here is a solution to problems of this nature, as developed for handling wood chips in the pulp industry. Similar systems could be adapted to the storage and handling of chemicals such as sulphur, limestone, calcium carbide, and rocksalt, as well as ores, fertilizers, oilseeds and food products in general.

Repeated requests from the pulp industry have prompted Stadler, Hurter & Co., a Montreal firm of consulting engineers, to develop a working answer to the problem of wood chip storage and handling. The answer: A specially designed storage bin to insure a constant supply of chips at the discharge outlet, and an unloading mechanism which loosens the chips in the bottom of the bin and throws a steady stream onto the take-away belt conveyor.

In designing the storage bin care has been taken to incorporate features that will eliminate the formation of dead pockets of material, bridging and hanging up of the solids, as well as hard packing and crushing of the particles. This does away with the need for air jets or vibrators to help move the material. In addition, a discharge opening is provided that favors the free flow of material.

The bin itself is rectangular; both ends and one of the sides are vertical to the full depth of the bin. Projecting inward and downward from the vertical side is a deflector to aid material flow and prevent compacting. The other side is vertical above the midpoint and continues downward at a 45-deg. slope to the discharge slot.

The discharge slot runs the full length of the bottom and is always open. Beneath it is a shelf, the same length as the slot, which catches material falling through the opening. Normally, material on the shelf piles back up to the slot, preventing the descent of more material from the bin. Removal of material from the shelf frees the bin opening for the flow of replenishing material.

Loading of the bin is done from a belt conveyor running lengthwise along the top. The belt is discharged by a reversible tripper, operating back and forth to distribute material evenly over the full length of the bin.

The twin-screw unloader is the real heart of the system. It is positioned under the bin so that the screws project in over the shelf at a right angle to the length of the shelf and bin. The unloader is track mounted on a carriage powered by a variable speed electric motor. This serves to move the carriage back and forth along the full length of the bin. Beneath the unloader carriage and between the tracks is a conveyor belt which catches the material spewing from the unloader and carries it to wherever it is needed.

The screws have a pitch and diameter of 18 in. Rotating in opposite directions at 47 rpm., they can move material off the shelf under the discharge slot and onto the lower conveyor belt at rates of 325 to 500 cfm. Rate variation is obtained by changing the distance between centers of the screws. Normal movement of the unloader carriage along the tracks is at a rate of 20 ft. per min., but this may be changed as desired. At the end of the track the direction of travel is automatically reversed.

In cases where more than one material is to be stored in the same bin, it is compartmented by crosswise bulkheads. Restricted loading and unloading of a single compartment is accomplished by using stops to restrict the travel of both the loading belt tripper and the twin-screw unloader.

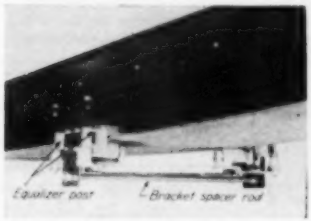
Where desired 'round bins or silos can be modified for installation of this new unloader.—*Improved Paper Machinery Corp., Nashua, N. H.*

## Equipment Cost Indexes

(Marshall and Stevens Indexes of Comparative Equipment Costs, 1926 = 100)

| Industry | Mar. 1951 | Dec. 1951 | Mar. 1952 |
|---|---|---|---|
| Average of all ..... | 181.2 | 177.1 | 180.2 |
| **Process Industries** | | | |
| Cement mfg. ..... | 174.0 | 169.5 | 173.8 |
| Chemical ..... | 182.0 | 177.5 | 180.8 |
| Clay products ..... | 169.0 | 164.5 | 167.8 |
| Glass mfg. ..... | 172.1 | 167.6 | 170.9 |
| Paint mfg. ..... | 175.3 | 170.8 | 174.1 |
| Paper mfg. ..... | 175.6 | 171.1 | 174.4 |
| Petroleum ind. ..... | 178.4 | 173.9 | 177.2 |
| Rubber ind. ..... | 180.8 | 176.3 | 179.6 |
| Process ind. avg.... | 179.4 | 174.9 | 178.2 |
| **Related Industries** | | | |
| Elec. power equip... | 183.6 | 179.1 | 182.4 |
| Mining, milling .... | 182.7 | 178.2 | 181.5 |
| Refrigerating ..... | 201.0 | 195.8 | 200.3 |
| Steam power ..... | 171.2 | 166.7 | 170.0 |

Compiled quarterly for March, June, September and December of each year by Marshall and Stevens, evaluation engineers, Chicago and Los Angeles. Indexes are prepared for 47 different industries, from which the eight process and four related industries listed here are selected. Published each month with the latest available revision. For a description of the method of obtaining the index numbers see R. W. Stevens, **Chemical Engineering**, Nov. 1947, pp. 124-6. For a listing of annual averages since 1913 see **Chemical Engineering**, Feb. 1952, p. 191.




### Belt Trainer Maintains Proper Alignment

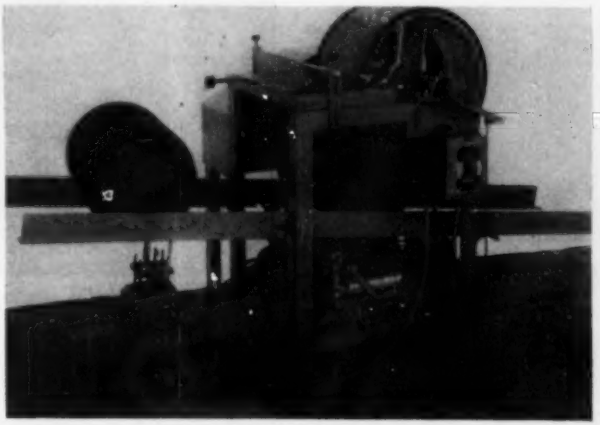
A belt trainer that automatically keeps wandering belts aligned can be installed on any make of conveyor which has the return belt exposed beneath the bed. It will help reduce wear, down-time and maintenance costs.

The trainer does not interfere with normal conveyor operation and does not mark or wear the belt in any way, it is claimed. It is designed for use on fabric or rubber-covered belts 3/16 in. or more thick, operating at speeds up to 200 fpm.

In use the trainer is bolted to the flanged rails on the underside of the conveyor. Flat sides of the belt run between two sets of knurled spring-loaded rollers, with the belt edges contacting two sets of equalizer posts. If the belt creeps to either side it presses against these posts and cocks the rolls to the new belt direction. This forces the belt back into alignment, and the trainer mechanism returns to normal setting.—*Rapids-Standard Co., Inc., 342 Rapistan Bldg., Grand Rapids 2, Mich.*

## IN BRIEF—A capsulated listing of this month's newsworthy equipment.


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### PRINTS 5-GAL. CANS AT POINT OF FILLING

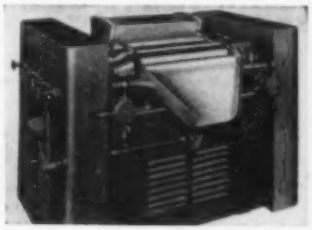
**Here is a new completely automatic printing press for 5-gal. drums and bail cans. With a capacity of 26 cans per min., you can reduce your inventory of cans by printing right on your production line.—Algene Marking Equipment Co., 324 W. 26th St., New York, N. Y.**

### Pre-Plasticizing Eases Molding Problems

Headaches associated with the injection molding of plastics are being reduced by the use of a pre-plasticizing unit mounted on the molding machine. Formerly the dry molding powder was plasticized by heat and pressure in the injection chamber directly ahead of the mold. The material is now reduced to a plastic state in a separate chamber and delivered to the injection chamber ready for molding.

Through this seemingly simple change in procedure a number of advantages can be gained, which permit increased output of better quality moldings merely by modifying present presses.

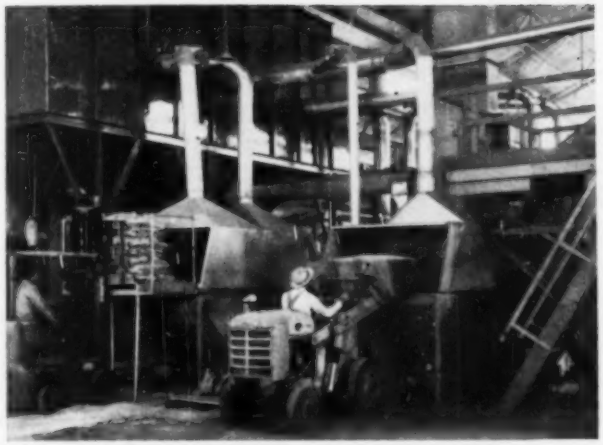
From a finished product standpoint, parts molded by the new technique are said to show more uniform color, have truer shape with absence of warping and are free of internal strains which might cause ultimate failure. These advantages are claimed for the molder: Up to double the plasticizing capacity per machine, with injection capacity increased by three times; lower injection pressures and temperatures with better temperature control; elimination of mold release compounds; and a lower density in the molded pieces, representing actual material savings of up to 10 percent. Also the expense of heat-treating molded parts to relieve them of internal strains is eliminated. —*Hydraulic Press Mfg. Co., Mt. Gilead, Ohio.*



### Three Roller Mill Uses Full Face Width

The newly designed Model 52T three roller mill achieves dispersion or particle size reduction along the full face of the rolls because the easily removed hoppers ride off the outside taper of the rolls. Thin-wall construction and full-length water cooling promote uniform grinding and temperature control.

Another feature is a specially designed balanced apron which provides uniform pressure of the thin take-off knife along the full face of the roll and eliminates scoring of roll ends. The apron is quickly detached from the front roll for cleaning.—*Charles Ross & Son Co., 148-156 Classon Ave., Brooklyn 5, N. Y.*



**DUST COLLECTING KEEPS FERTILIZER PLANT CLEAN**

**All steps in the process of making mixed fertilizers at Sunland Industries are suitably hooded or enclosed and vented to a cloth tube type of dust collector. These men are loading batching bins vented to the dust collector on the left. Material recovered in the dust collector is returned to process.—American Wheelabrator & Equipment Corp., Mishawaka, Ind.**



### Turbo-Dryer In Larger Packaged Unit

A new Turbo-Dryer, which comes in a packaged unit, has an evaporative capacity 2 to 4 times that of current models, according to a recent announcement. This type of dryer handles fragile or heat-sensitive materials, ranging from thick slurries to fine powders, through repeated piling and spreading.

Known as the N series, the new dryers will be furnished completely insulated and will be provided with variable-speed drives for both rotation of the tray structure and the turbo-fans. They will have a housing diameter of 9½ ft., compared with the 6 ft., 2 in. of the smaller L series. Height depends on the number of shelves and varies from 7 ft., 10 in. to 11 ft., 9 in. Evaporative capacities are from 50 lb. of water per hr. at 100 deg. F. to 750 lb. at 300 deg.—*Wyssmont Co., 31-04C Northern Blvd., Long Island City 1, N. Y.*

### Mono-Bed Demineralizer Operates Automatically

Automatic operation has now been built into the Penfield Mono-Bed demineralizer. Whenever the effluent's conductivity falls below standard, the treated water is automatically discharged and lights (or other warning system) signal the need for activation of a regeneration cycle.

The simple turning of a single switch then puts the unit through its regeneration cycle completely automatically, including rinsing and recutting in the effluent when desired resistivity is reached. During this cycle the regenerative tanks are automatically refilled with water so that fresh acid and caustic may be added in preparation for the next regeneration cycle.—*Penfield Mfg. Co., Meriden, Conn.*

*See Louisville for*
CREATIVE DRYING ENGINEERING

# PRODUCTION WILL BE UP 150%—COSTS DOWN 2/3's WITH THIS NEW LOUISVILLE DRYER

KNOW THE RESULTS *before you buy!*



| | |
|---|---|
| Installed Cost | $100,000 |
| Annual Production (tons) | 10,000 |
| Drying Cost Per Ton | $ 3.11 |
| Space Occupied | 1,900 sq. ft. |

| | |
|---|---|
| Installed Cost | $ 95,000 |
| Annual Production (tons) | 25,000 |
| Drying Cost Per Ton | $ 1.04 |
| Space Occupied | 1,000 sq. ft. |

*Ask for new treatise on subject of rotary dryers.*

***Other General American Equipment:***
Turbo-Mixers, Evaporators, Dewaterers, Towers, Tanks, Bins, Filters, Pressure Vessels

PROCESS EQUIPMENT DIVISION
GENERAL AMERICAN
TRADE MARK

**PROBLEM:** manufacturer wanted to improve drying operation. Costs high, production low.

**SOLUTION:** manufacturer called in Louisville engineers.

These engineers started the Louisville method for predetermining results . . . and for fitting the dryer to the job.

Step 1. *Louisville engineers completely surveyed plant operations and previous drying methods.*

Step 2. *Recommended dryer design was checked in Louisville laboratory in actual drying test.*

Step 3. *A double check with larger pilot plant equipment actually installed in customer's plant.*

Step 4. *All factors determined and solved, full scale drying equipment was fabricated.*

Step 5. *Final installation will be checked for mechanical perfection and drying efficiency to insure anticipated results and purchaser's satisfaction.*

**SUGGESTION:** Why not call in a Louisville engineer to look over your drying operation? There's no obligation . . . and the results may pay big dividends.

**LOUISVILLE DRYING MACHINERY UNIT**
*Over 50 years of creative drying engineering*
**GENERAL AMERICAN TRANSPORTATION CORPORATION**
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OFFICES IN ALL PRINCIPAL CITIES



**Portable Fire Extinguisher Is Easily Serviced**

A serviceable new pressure-operated dry chemical portable fire extinguisher can be recharged easily in the field. You simply pour 5 lb. of dry chemical into the powder chamber and, using a convenient source of compressed air, pressurize the unit to 150 psi.

This unit has the same diffusion discharge pattern featured by the company's 20 and 30-lb. models. The nozzle discharges a cloud-like pattern which is said to be most effective for extinguishing flammable liquid and electrical fires.—*Walter Kidde & Co., 40 E. 34th St., New York 16, N. Y.*

**Safety Goggle Is Light, Comfortable**

A comfortable new acid safety goggle, named Duo-Chem, features a bright yellow vinyl frame, the ASA color code for acids. Light weight and comfort through the use of soft vinyl frame and optical lens are claimed. Even though it will fit over personal glasses, Duo-Chem weighs only a little more than 1 oz.—*United States Safety Service Co., 1215 McGee, Kansas City 6, Mo.*

**Thermal Element Detects Still Blow Off**

A seal-pot venting and alarm system for alcohol stills has been built around a thermally sensitive element called the Detect-A-Fire, described previously on p. 184 of our Jan. 1952 issue. Explosion hazards and product losses resulting from the venting of alcohol vapors to relieve excess still pressure are thereby eliminated.

Past practice for venting excess still pressure had been simply to provide a mechanical relief device which allowed alcohol vapors to escape into the still building. Replacement of the relief valve by seal pots vented outside the building eliminated the explosion hazard. This raised the problem of keeping loss of alcohol vapor to a minimum. Here is where the Detect-A-Fire comes in.

The thermally sensitive Detect-A-Fire is mounted in the seal pot vent duct. Escaping hot vapor (about 220 deg. F.) causes the detector to actuate both visual and audible alarms that enable the still operator to take immediate corrective action. An alarm bell or siren sounds, the green safe operation light on the control panel shorts out while a red trouble light goes on, along with the appropriate drop tag.

The inherent design of the Detect-A-Fire makes it suitable for use in atmospheres containing explosive vapors. Safety requirements for wiring these installations were met by enclosing the leads from each detector in an explosion-proof connection box threaded directly onto the upper end of detector. In addition, all wiring, panels and warning devices are suitably enclosed or shielded.

This system has been installed in 21 Schenley distilleries throughout the United States and Canada.—*Fenwal Inc., Ashland, Mass.*



**Glass Tubing Manipulator Protects Workers' Hands**

The Grip-Safe, molded of neoprene, offers laboratory workers reliable protection when handling glass tubing, while at the same time permitting easy manipulation. The gentle, firm gripping action of the Grip-Safe permits you to slide thermometers or tubing into stoppers without the excessive or uneven pressure which breaks the glass. If breaking should occur, your hands, wrists and knuckles are protected.

Most sizes of commonly used tubing, as well as irregular shaped tubing, such as tees and ells, are readily accommodated. Grip-Safes are packaged two in a box and priced at about $6 per box.—*Labline, Inc., 4710 W. North Ave., Chicago 39, Ill.*



CLEAN GOGGLES HERE

**Cleaning and fog-proofing of safety glasses and goggles are facilitated by this new cabinet, which dispenses liquid cleaner and tissue.—Allen Optical Co., 85 Allen St., Buffalo 2, N. Y.**

**Face Shield Mounts on the Chest**

A new protective face shield mounts on the wearer's chest, much like the make-up mirror which milady hangs around her neck. Some of the advantages of this design are:

1. Complete relief from the head strain caused by head-mounted face shields.
2. Improved vision and ventilation.
3. For the female worker, elimination of mussed hair-dos.

The standard model is supplied with a clear Chipruf visor 8 in. long by 0.04 in. thick. Visors are available in various sizes for impact resistance, chemical splashes, and hot operations.—*Mine Safety Appliances Co., Braddock, Thomas, and Meade Sts., Pittsburgh 8, Pa.*

**Plastic Safety Lenses Resist Impact, Scratches**

Plastic safety lenses are now being made in a new air-conditioned room where the lenses are baked in glass molds. This setup eliminates dirt that inevitably shows up in plastic lenses and affects their appearance and quality.

Tests have disclosed the lenses are highly resistant to such eye hazards as splashing chemicals, weld spatter, emery wheel sparks, and the high-velocity impact of hard, small particles. In laboratory tests it was discovered that the lenses survive the impact of a 9-oz. steel ball dropped from a height of nearly 4 ft.; a 14-oz. steel needle dropped from a height of more than 4 ft.; and a small projectile traveling at a speed of close to 100 ft. per sec.—*American Optical Co., Southbridge, Mass.*

# NEW ACE PARIAN®

chemical piping




**PHYSICAL CHARACTERISTICS:**

Specific Gravity — 1.12
Tensile Strength — 2000 psi
Resistance to Cold Flow—Excellent
Deformation Under Load at 122°F — 0.6%
Impact Strength — Izod 32 ft. lbs./in. notch
Resistance to Continuous Heat, no load—212°F
Low-Load Heat Distortion Temp.—105-110°F
Coeff. Thermal Expansion/Deg. F — $9x10^{-5}$
Resistance to Sunlight — Excellent
Water Absorption — 0.04-0.06%
Elongation — 100-200%

No other chemical piping offers such a remarkable combination of chemical resistance, high impact strength, and easy workability as new ACE Parian. Formed of Polyethylene with all the skill of American Hard Rubber Company's 101 years of specialized experience, it is ideal wherever both the interior and exterior of the pipe are exposed to corrosion. Odorless and non-toxic, it's also good for foods and beverages.

All standard pipe sizes from ½" to 2". Standard lengths of 10 feet. It's easy to thread with standard dies, and a complete line of molded Ace Parian fittings are available.

Why not glance over the physical characteristics and specific reagents at right, and see how many places in your plant this new pipe can save for you!

chemical resistance at 77 deg. F.

**EXCELLENT:**
Sulfuric Acid, 10-30%
Calcium Chloride, 15% aq.
Calcium Hypochlorite
"Dupanol" ME, 10% aq.
Triethanolamine
Ferric Sulfate, 15% aq.
Saturated Salt Water

**GOOD:**
Sulfuric Acid, 60% — concentrated
Hydrochloric Acid, conc. (10-37%)
Sodium Hydroxide, 10-30%
Ethyl Alcohol (denatured)
Acetone
Formic Acid
Hydrofluoric Acid, 48%

**FAIR:**
Nitric Acid, 10%
Acetic Acid, 10%
Ammonium Hydroxide, 10-28%
Dioxane
Xylene
Sodium Bisulfite
Linseed Oil

**POOR:**
Benzene
Ethylene Dichloride
Butyraldehyde

**UNSUITABLE:**
Nitric Acid (Conc. 70%)
Acetic Acid, glacial
Oleic Acid, conc.
Most Chlorinated solvents
Lubricating Oil
Ethyl Acetate

Parian is only one of many ACE rubber and plastic products serving the chemical industry. Tanks, pumps, piping, valves, fittings are available in standard or special constructions for complete chemical processing, storage or circulating systems. Ask our engineers to recommend the most economical corrosion-resistant equipment for your processes.

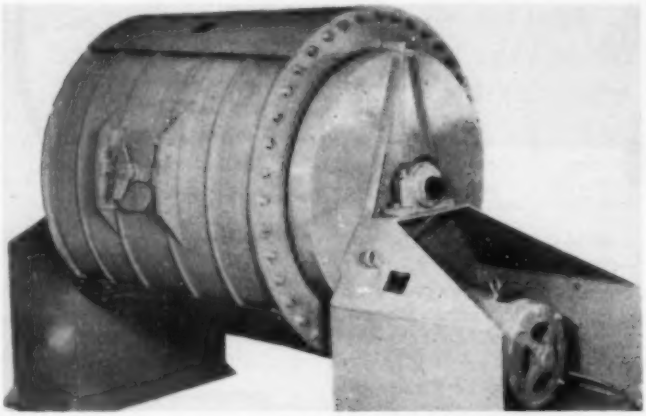



**ACE rubber and plastic products**

**AMERICAN HARD RUBBER COMPANY**
93 WORTH STREET • NEW YORK 13, N. Y.



CLASSIFIER SCREW is protected by Linatex covering.



BALL MILL has fabricated one piece Linatex liner mounted in steel shell.

# Natural Rubber Resists Wear

**Fresh latex, coagulated and cured without heat by a special process, makes a tough rubber for protecting processing equipment against abrasion.**

Occasionally a product appears which is new to our market but which has been thoroughly proven out in foreign industrial applications. Such a material is Linatex, a special form of natural rubber manufactured by the British in Malaya.

Backed by a 25-yr. service record, Linatex is said to show unusual resistance to abrasive wear, exceptional strength and tear resistance, resilience several times that of other rubbers, as well as good resistance to chemical attack and exposure to the elements. Furthermore, simply by using a cold cement, Linatex can be bonded not only to itself but also to wood, metal or cement.

Key to the superiority of this natural rubber is said to be a process (B. P. 437,928) based on the use of fresh rubber latex which preserves the crystal structure of the rubber. Attempts to duplicate Linatex by making it from preserved latex in this country have all failed.

Extensive industrial use of Linatex has been made throughout the British Empire, particularly in mining and ore dressing. Industries with wet abrasion problems, such as sand and gravel producers and coal washers, are big users. It is used in ball mills where avoidance of metallic contamination is important, such as in the pottery industry for grinding frit, colors, enamels and glazes. A special ball mill design has been developed with the Linatex liner fabricated in one piece.

Chutes, pumps, launders, pipelines and tanks can be lined with this material. Chute or hopper liners which must take heavy impact abuse have to be carefully engineered to assure maximum wearing qualities. The main problem here is to provide sufficient resilience; this is done by making the liners thick enough to absorb shock.

Numerous case histories are available. For example, an ore mill installed a 42-in. wide, seven-ply conveyor belt of 32-oz. duck with a wearing face of $\frac{3}{16}$-in. high-tensile rubber. After conveying 12.5 million tons over a 2-yr. period the belt had worn down to the canvas. Following resurfacing with $\frac{3}{16}$-in. Linatex, the belt handled over 51 million tons. In another mill the peripheral liner of a sand pump was built up with Linatex. Now the pump runs for $2\frac{1}{2}$ yr. between overhauls, whereas formerly the white iron castings had an approximate life of 90 days.

In common with other natural rubbers Linatex is not resistant to oil and grease. However, where exposure conditions are not too severe you can use a protective paint. In some cases, such as rubber mountings, metal shields offer effective protection.

Linatex is attacked by strong oxidizing acids, such as nitric acid, and also by a number of organic acids. Although it can stand the temperature of saturated steam up to 50 psi. for reasonable periods of time, exposure to dry heat in excess of 150 deg. F. for any prolonged period will deteriorate the rubber. On the other hand it will withstand low temperatures without losing its resiliency.

Linatex is available in this country in the form of sheets ranging in thickness from $\frac{3}{16}$ in. to $\frac{1}{2}$ in.—*Linatex Corp. of America, Rockville, Conn.*

### Polyethylene Fittings Constructed by Welding

Agilene polyethylene fittings are now furnished in flanged tees, crosses, 45-deg. and 90-deg. elbows up to 6 in. nominal pipe size. The fittings are made of fully welded construction to standard dimensions for Class 125 cast iron flanged fittings and can be incorporated into existing pipelines. It is recommended that these fittings be used with split sheet metal back-up flanges to avoid deformation of the flanges through bolt pressure.—*American Agile Corp., P. O. Box 168, Bedford, Ohio.*

# You get real versatility with this "Lightnin Mixer"

## RUN AT DIFFERENT SPEEDS

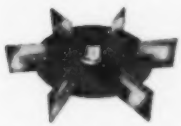


**YOU CAN GET** up to 16 standard AGMA speeds with this mixer—from 16.5 to 420 RPM.



**TO CHANGE SPEED** you just replace these two change gears with another pair of different ratio.

## MIX DIFFERENT FLUIDS



**FLAT BLADE TURBINE** can handle most fluid agitation requirements. However, MIXCO stocks a wide range of interchangeable impellers—one for every type of application.



**REMOVABLE BLADES** permit you to increase or decrease HP by adding or subtracting blades. Impellers can also be split and blades removed for easy passage through small openings.

## MOUNT ON DIFFERENT TANKS



**BY INTERCHANGING** standard components, you can easily adapt the same mixer to open tanks, closed tanks or make it into a bottom-entering unit.



**SERIES "E" LIGHTNIN MIXER** for heavy-duty fluid agitation. Available in sizes from 1 to 800 HP.

## AND GET GUARANTEED RESULTS—YET YOU PAY ONLY STANDARD PRICES!

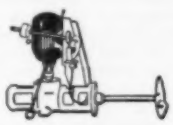
# MIXCO

## fluid agitation specialists

**EVERY LIGHTNIN MIXER IS GUARANTEED TO DO THE JOB *RIGHT***



**PORTABLE**
**⅛ to 3 HP**



**SIDE ENTERING**
**1 to 25 HP**



**TOP ENTERING**
**¼ to 500 HP**

## MIXING EQUIPMENT Co., Inc.

**128 Mt. Read Blvd., Rochester 11, N. Y.**

***In Canada: William & J. G. Greey, Ltd., Toronto***

Please send me the bulletins checked:

- ☐ B-102 Top Entering Mixers (turbine and paddle types)
- ☐ B-100 Condensed Catalog (complete line)
- ☐ B-78 Top Entering Mixers (propeller type)
- ☐ B-75 Portable Mixers (electric and air driven)
- ☐ B-76 Side Entering Mixers
- ☐ DH-50 Laboratory Mixers

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____



**Vapor-Tight Fixture Makes Relamping Easy**

Combining in a convenient unit assembly receptacle, globe and guard, the new V-51 series of vapor-tight lighting fixtures makes relamping or cleaning safe, swift and simple. Removing or replacing reflectors, too, is done with a single twist, made possible by a special attachment consisting of a neoprene ring which snaps securely into a groove.

The V-51 line includes 18 different types of malleable iron bodies for pendant, ceiling or bracket mounting. Each body takes both 100 or 150-200 w. unit assemblies. Complete interchangeability of parts permits the assembling of 256 complete fixtures, using only 32 basic components.

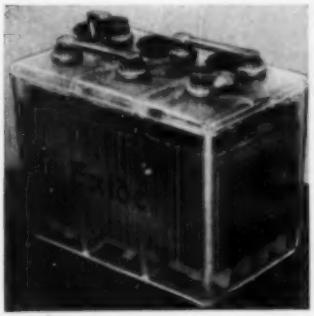
Just recently put into production is another new line, the AA-51 series of vented explosion-proof fixtures. The same unit-assembly principles are used. Safety is assured by the fact that five full threads of the canopy are engaged whenever contact is made or broken, thus confining any arcs in approved explosion-proof method even if line current should accidentally be left on when removing or replacing the fixture.

The venting feature results in a more even heat distribution and much cooler operating temperature. The entire lower edge of the hood serves as a continuous louver, giving as much as 12 times the louver space of previous fixtures.—*Appleton Electric Co., 1701 Wellington Ave., Chicago 13, Ill.*

**Electronic Amplifier Spots Mechanical Troubles**

If you think you missed your calling and should have been a physician, you can at least practice diagnostics with an engineer's stethoscope. A new electronic amplifier, known as the Electro-Probe, makes it possible to locate and diagnose trouble spots in machines, piping, etc., by amplifying noises and vibrations.

The device includes pick-up probe, three-stage amplifier, speaker and headphones. List price is $110.—*Erwood, Inc., 1770 Berteau St., Chicago 13, Ill.*



**Storage Batteries In Polystyrene Cases**

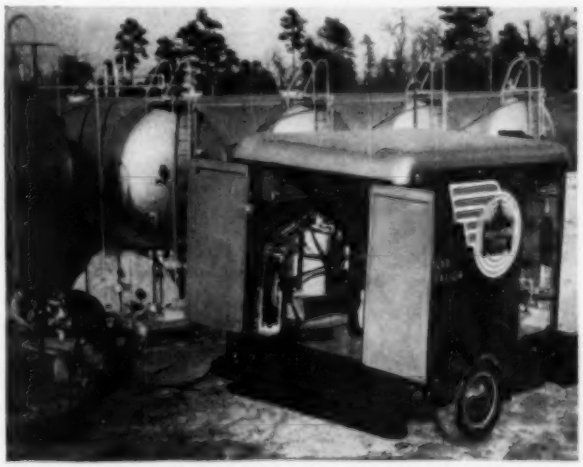
A new series of storage batteries of two-cell and three-cell construction for stationary applications offer distinct advantages in space and weight saving, maintenance and improved dependability, according to a recent announcement.

Designated as Exide Type PLX, the batteries are housed in transparent polystyrene cases which show at a glance the level of the electrolyte and the approximate state of charge. Markings on the case indicate the recommended high and low electrolyte levels. Built into each outer cell is a chamber in which a red, a white, and a blue ball float in electrolyte when the battery is fully charged. When the battery is 10 percent discharged the blue ball sinks. When it is one-third discharged the white ball sinks, and when two-thirds discharged the red ball goes down.

An improved safety feature is an automatic venting device of clear polystyrene built into each cell to prevent excessive accumulation of gas.

The two-cell batteries have a 50 amp.-hr. capacity at the 8-hr. rate, while the three-cell units have a 100 amp.-hr. capacity.

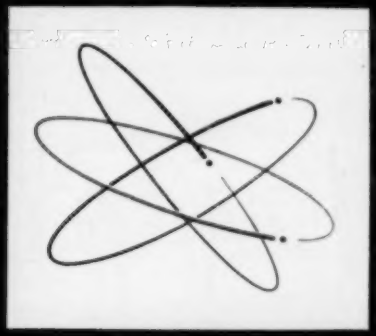
Another announcement of interest to battery users describes six improvements in the Exide-Ironclad storage battery. One of these improvements is the introduction of a new alloy, Silvium, in the construction of the positive-plate grid. An alloy of silver, lead and other components, Silvium is said to be highly resistant to corrosion and thus provides a longer positive grid life.—*Electric Storage Battery Co., Box 8109, Philadelphia 1, Pa.*



MOBILE LUBRICATION SERVICE FOR VALVES

**A fleet of special trucks and trained crews of lubrication specialists can take over the responsibility of proper lubrication of all lubricated valves on a customer's property, be it a chemical plant, refinery, tank farm or pipeline. Service is on a contract basis. The customer is provided with complete service records, and each valve is date-tagged after each servicing.—Desco Service Co., 804 Louisiana Ave., Shreveport, La.**

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## *all-electronic control*

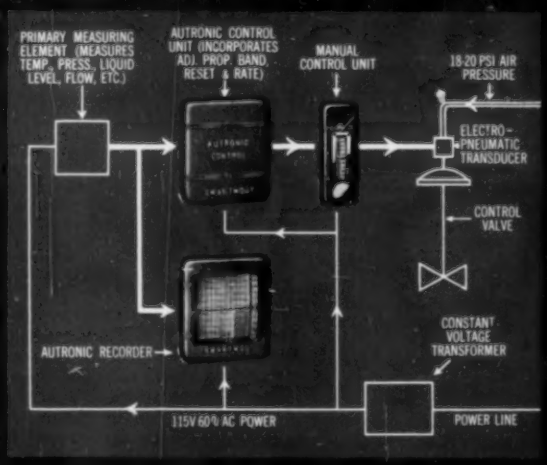


of pressure

temperature

flow

and level . . .

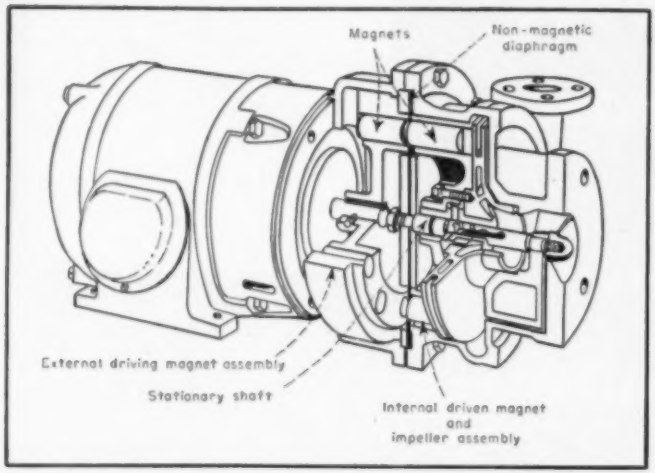



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# Leakproof Pump Has No Seals

**Impeller, combined with an assembly of permanent magnets, is driven by a matching external magnet assembly. With no direct coupling, stuffing box is eliminated.**

Following three years of development and exhaustive field testing Peerless has unwrapped its new magnetically driven horizontal pump. The pump is leakproof, with no rotating seals, no packing, no rotating member between the driver and the driven unit. The impeller, completely sealed off inside the pump housing, is driven by magnetic force.

By referring to the cutaway drawing of the pump above you can see that the pump is an end suction type, with the motor mounted in a normal direct-connected position. However, instead of being directly connected to the pump, the motor shaft terminates just short of a stationary non-magnetic diaphragm which seals off the inside of the pump. Mounted on the motor shaft is an assembly of permanent magnets. Behind the diaphragm is a matching magnet assembly mounted in tandem with the pump impeller on a stationary shaft. Magnet and impeller are coupled together with bolts. Lubrication of the bearing surfaces is done by the liquid being pumped.

Applications for the magnetic-drive pump are expected to center around processes where a closed system of liquid flow is necessary or where liquid contamination, leakage and shaft corrosion are serious problems. Hazardous, toxic, odoriferous, corrosive, or extremely hot or cold liquids can be handled. The one limitation that must be observed is that suspended solids cannot be tolerated, since the liquid being pumped serves to lubricate the internal bearing surfaces. This is in common with another pump of this type described in a previous issue. (*Dec. 1951, p. 190*).

Some of these pumps have been tested for a period of time on ammonia, liquid chlorine and organic acids in plants of several prominent chemical producers.

Almost any of the common materials of construction can be used, so long as a non-magnetic material is used for the diaphragm separating the two sets of magnets. Size of this type of pump, however, is limited at the present time to the range of 1 to 2 hp. and flows up to 150 gpm. at 70 ft. of head, rotating at 1,760 rpm.

Beyond the 2-hp. size, several 10-hp., 3,460-rpm. vertical pumps have been developed using the same principle of operation. Such units can be designed to meet specific application requirements.—*Peerless Pump Div., 301 W. Ave. 26, Los Angeles 31, Cal.*

### Electromagnetic Pump Has No Moving Parts

The need for a pump to handle liquid metal coolants in atomic energy work has fostered the development of a direct-current electromagnetic pump which has no moving parts. Capable of being run continuously with liquid metals at 750 deg. F., the pump is being used to circulate a liquid metal coolant through an experimental breeder reactor at the Atomic Energy Commission's testing station in Idaho.

The pump consists essentially of a straight piece of tubing, two copper bars and an electromagnet. The tubing is either thin-walled stainless steel or nickel-chrome alloy pressed into a rectangular cross-section. Heavy copper conductor bars are silver soldered to opposite sides of this tubing. This assembly is connected into the pipeline with the poles of an electromagnet placed on either side of it.

An electrical current entering the tubing wall passes through the liquid metal and develops in it a longitudinal thrust. A current of 20,000 amp. at 1 v. operates the pump.—*Argonne National Laboratory, P. O. Box 5207, Chicago 80, Ill.*



### Flow Control Valve Designed for Slurries

Designed particularly for proportioning and controlling pulp and paper stock and similar slurries, the new Ratogate valve can be used for any low-pressure automatic service.

A wide range of operation is obtained because the diamond-shaped outlet, formed by the V-notches of the discharge port and the sliding gate, provides a minimum wetted perimeter and maximum opening area. This design reduces the accumulation of solids which could block the passage, especially at low flow rates.

The valve is said to be entirely self-

# DOWELL SERVICE

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## Dowell Service cleaned seven heat exchangers in 19 hours!

This refinery had 7 heat exchangers that were badly fouled. Minimum downtime for cleaning was a prerequisite to maintain production. Dowell Service removed 80% of the deposits from the process sides in only 19 hours. As a result the operating pressure drop through the system was lowered from 80 p.s.i. to 5 p.s.i. with an equally satisfactory drop in operating temperatures.

Dowell Service is the answer to the maintenance engineer's demand for *fast, efficient, economical* cleaning. Maintenance time and costs can be cut by applying Dowell Service to condensers, process towers, boilers . . . to nearly any type of industrial equipment. Dowell engineers fill the equipment to be cleaned with liquid solvents. These solvents are designed to clean places inaccessible to other methods. Costly dismantling is eliminated and downtime is shortened.

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**Oil, water, algae emulsion removed from refinery circulating water system in only 6 hours.**

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**Water side of 15 tube and shell condensers cleaned for refinery. After Dowell Service, gasoline left condenser 20° cooler than when condensers were mechanically cleaned. Chief engineer estimates Dowell Service paid for itself in approximately 12½ days.**

•

**Partially carbonized oil and grease caused trouble in five 150,000 lb./hr. boilers in a Southwestern refinery. Dowell Service removed the deposits from each boiler in a few hours.**

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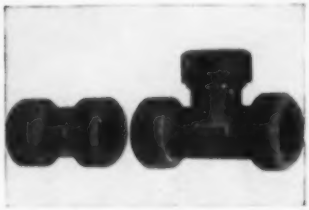
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cleaning. It is swept clean by the agitating action of the flow passing through the body, and there are no internal pockets where dead stock can collect. A sight glass permits inspection of the discharge port and the sliding gate.

All Ratogate valves are equipped with pneumatic cylinder operators and positioners. Standard material of construction is Type 304 stainless steel, but other materials are also available.—*Fischer & Porter Co., 6110 County Line Road, Hatboro, Pa.*



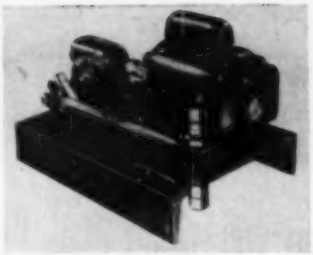
**Malleable Iron Fittings Eliminate Thread Cutting**

Standard size plastic and steel pipe from ¼ through 2 in. can now be joined without threading by using Telsco malleable iron threadless fittings. These fittings are factory assembled and ready to use. All you do is insert the plain pipe end into the fitting and tighten the nuts with an ordinary wrench.

Pictured in the cut are a coupling and a tee. It can be seen that each opening in the fittings is provided with a screw-threaded locking ring. Inside the opening is mounted an annular neoprene ring with a large enough I. D. to fit around pipe introduced through the opening. The neoprene ring is seated against a shoulder in the body of the fitting. When the locking ring is tightened after inserting a pipe in the fitting it compresses the neoprene ring around the pipe, making a tight seal.

It is said that the Telsco joint is actually stronger than a threaded joint because the pipe walls have not been weakened by threading. The neoprene ring also acts as a cushion to protect the pipe from the strains of expansion, contraction and vibration.

The tough, shock-resistant, high tensile-strength malleable iron castings are manufactured according to ASTM specification. A special rust-preventive process renders the fittings resistant to corrosion.—*Texas Lawn Sprinkler Co., Inc., 5422 Redfield St., Dallas, Tex.*



**Proportioning Pump Features Simple Design**

Model 100 chemical proportioning pump features a new simplified design which makes for maximum versatility. Pump heads are interchangeable; any simplex can be readily converted into a duplex.

Maximum capacity is 12 gal. per hr. for discharge pressures up to 300 psi. Output is controlled by moving an adjustment nut along a calibrated scale on the eccentric, shortening or lengthening the stroke.—*Neptune Pump Mfg. Co., 4912 N. 6th St., Philadelphia 20, Pa.*

**Series R Durcopump For Corrosive Solutions**

Industrial installations of the recently developed Series R Durcopump, with over a year of service in some instances, indicate the unit to be very satisfactory for handling corrosive solutions. Among the design features aimed at combating corrosion are interchangeability of wet-end parts in various alloys to meet changing conditions, impeller vanes heavier at the tips where corrosion and erosion are most severe, and the fact that no threads are exposed to solutions.

The pump has a rugged cast iron frame, reinforced at the top to obtain minimum distortion, and throughbored for best bearing alignment. The casing is vertically split, with an integral stuffing box. Balance ports are located in the impeller to relieve pressure in the stuffing box and the shaft is threaded into the impeller, thus eliminating an impeller nut.—*The Duriron Co., Inc., Dayton 1, Ohio.*



**Hydraulic Pump Doubles As Fluid Motor**

A new 2,000-psi. vane-type hydraulic pump, said to incorporate a new principle of radial balance and construction, can also be used as a fluid motor. No alterations of any kind are necessary within the unit itself to utilize its two-way performance. It can be used for either clockwise or counter-clockwise rotation.

Four sizes are available; each size is offered with a choice of cam rings to widen the range of delivery or torque rating. This provides a range of eight different capacity levels. In pump applications, these capacities are from 2½ to 60 gpm.—*Denison Engineering Co., Columbus, Ohio.*



**HEAVY-WALLED PLASTIC PIPE FOR PRESSURE OR VACUUM**

**ring increased wall thickness, Type WS plastic pipe has been developed primarily for water service installations and applications involving high vacuum. Working pressure is 120 psi. in sizes from ¾ to 1½ in. and slightly less in larger sizes up to 6 in.—Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio.**

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Isoprene
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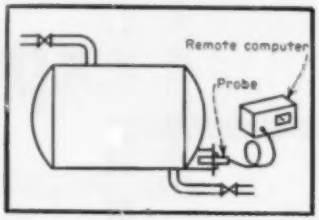
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ULTRASONIC probe and computer.




HERE is typical installation.

# Ultrasonics Measures Viscosity

**The resistance of fluids to ultrasonic vibrations is electronically computed and recorded. Result—a new tool for continuous viscosity measurement and control.**

Viscosity of liquids and suspensions is of vital concern to the chemical engineer. In measuring this property he is too often aware of a task that is bothersome, time and labor consuming. Here is a new instrument that greatly simplifies this task and could likely put continuous viscosity measurement in the same class with continuous pH control.

The Ultra-Viscoson uses ultrasonic waves to measure viscosities of Newtonian liquids and apparent viscosities of non-Newtonian liquids. The operation is both continuous and automatic. The sensing element is a probe the size of a fountain pen consisting of a thin alloy steel blade protruding from a stainless steel barrel. Threads on the barrel allow the element to be screwed into a tapped hole in the side of a tank or the wall of a pipe. Connected to the probe by a cable of any length up to 1 mi. is an electronic computer.

Here is the way the unit works: Ultrasonic waves are produced by the sealed probe in the liquid surrounding it. This causes minute layers of the liquid to slip back and forth over one another at a corresponding frequency with bidirectional or alternating motion. The electronic computer instantaneously computes the energy required to produce this sliding motion; this energy is proportional to the viscosity of the liquid.

Operating frequency of the Ultra-Viscoson is 28 kc. per sec. and the peak amplitude of vibration of the probe is less than 1 micron. The ultrasonic energy level in the liquid is very low—in the range of microwatts. This insures that there will be no change in the characteristics of the sample due to the effect of the ultrasonic energy. It is also far below cavitation levels.

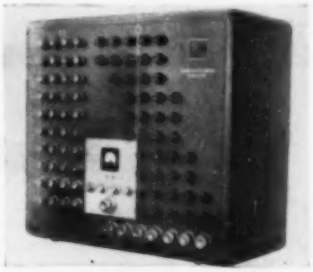
On the face of the computer is a swinging needle and scale which is marked from 0 to 50. A knob permits selection of the following ranges: 0–50, 0–500, 0–5,000, 0–50,000. The units are the product of viscosity and fluid density, or cp. × gm./cc.

Because reading of the Ultra-Viscoson is instantaneous and continuous you can secure continuous curves of the readings by connecting a standard recorder or recorder-controller to the outlet provided in the back of the computer. Such curves have been found to be extremely valuable in research and development. When tied in with a production operation, such as the blending of two fluids having different viscosities, it provides a continuous record of the blending operation. At the same time it can automatically position control valves on the two fluid streams.

A large number of installations have already been made throughout the chemical and petroleum industries, even though the instrument has been on the market only a year. For instance, the Ultra-Viscoson is being used to measure the degree of polymerization of polystyrene, phenol-formaldehyde, melamine and alkyd resins for production control purposes. Melts of polyethylene and various casting resins are readily measured. Work is now in progress to apply the Ultra-Viscoson directly to extruding machines to automatically control the viscosity at the extruding die. Other materials where the instrument can be applied are soaps, detergents, paper coatings, printing inks and lube oils.

A modified Ultra-Viscoson is being used at thousands of atmospheres of pressure to study viscosity and polymerization processes in a sealed high-pressure vessel. Other standard instruments are similarly employed at temperatures ranging from −150 to +650 deg. F., from vacuum to 500 psi. pressure.

Currently the Ultra-Viscoson is priced at $1,000, exclusive of installation costs.—*Rich-Roth Laboratories, 673 Connecticut Blvd., E. Hartford 8, Conn.*



**Electrical Computer Figures Equilibrium Data**

A new electrical phase-equilibrium computer will solve in a very few minutes a complex flash equilibrium relationship which would ordinarily require up to 1½ hr. to solve by manual procedures. Problems of this type are frequently encountered in the determination of optimum operating conditions for fractionators, absorbers and condensate separators.

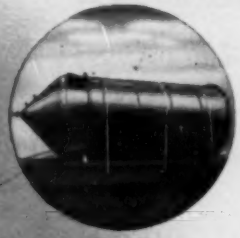
The computer is essentially a resistance bridge network in which the equilibrium conditions are achieved by an electrical balance of the bridge. The only power source necessary for operation is 110 v. a.c.

Computers can be built to handle any desired maximum number of constituents and will solve systems having an intermediate number of components without any modification of the instrument. The model illustrated handles up to ten components and gives answers reproducible to the first three significant figures. Absolute accuracy is no better, of course, than the accuracy of the equilibrium constants of the system.

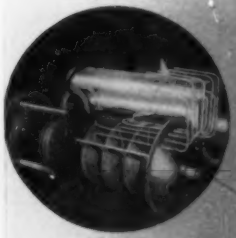
In a typical problem, the data introduced into the machine are the analysis of the feed in terms of the mole fraction of each constituent and the equilibrium constants for each constituent at the given temperature and pressure. The vapor-liquid system is represented by the resistance bridge



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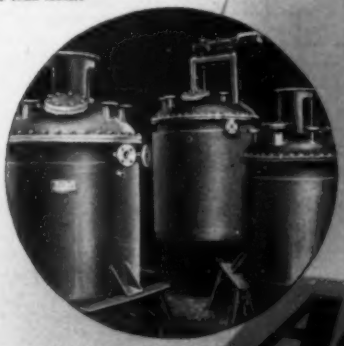
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network and the equilibrium condition is achieved by the bridge balance on a null indicating meter.

This balance gives the ratio of total liquid to total vapor in the output. Subsequent balances solve for the liquid fraction of each constituent and the total vapor in terms of moles per mole of feed.—*Beckman Instruments, Inc., South Pasadena, Cal.*




**Indicating Pyrometer With Straight-Line Control**

Model 293 Capacitrol incorporates the new Line-otrol feature which, it is claimed, automatically reduces to a minimum the on-and-off variation of the instrument above and below the control point. It provides a type of proportioning control for such equipment as ovens and furnaces which heretofore has been obtainable only through the use of auxiliary devices or more costly equipment.

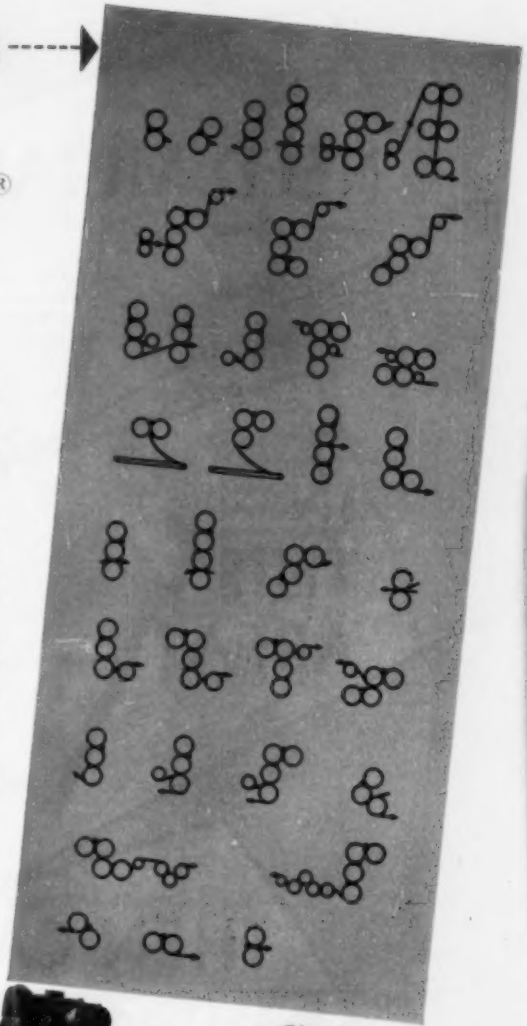
The new instrument uses the same measuring system with Alnico V magnet and control assembly as its predecessor, Model 292, but with the further advantage of being able to compensate for process transfer lags. A wide range of standard scales in various thermocouple calibrations is available.—*Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.*

**Electronic Instrument Measures Two Variables**

A new electronic inductance bridge receiver combines in a single instrument a number of functions which formerly required the use of two instruments. The user can now indicate, record, integrate and control flow, liquid level or motion with a single circular chart instrument. Data can also be retransmitted pneumatically to a second receiver remotely located.—*Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.*

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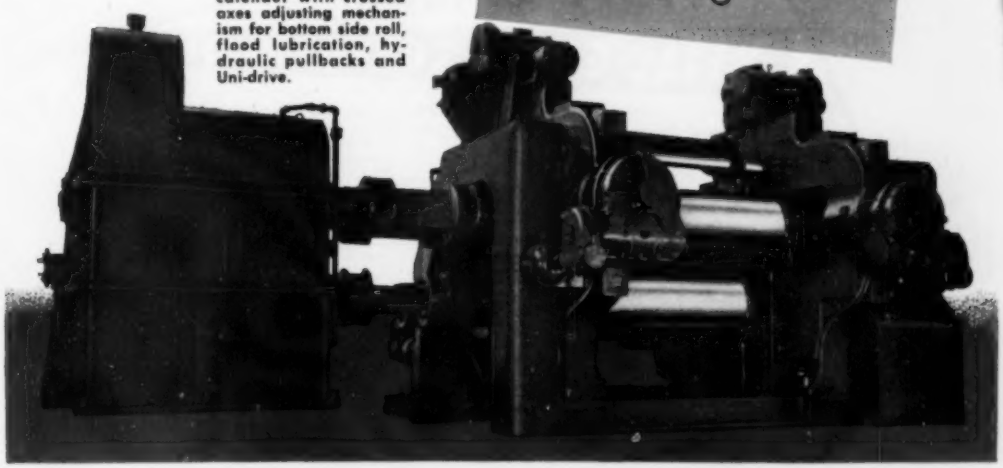
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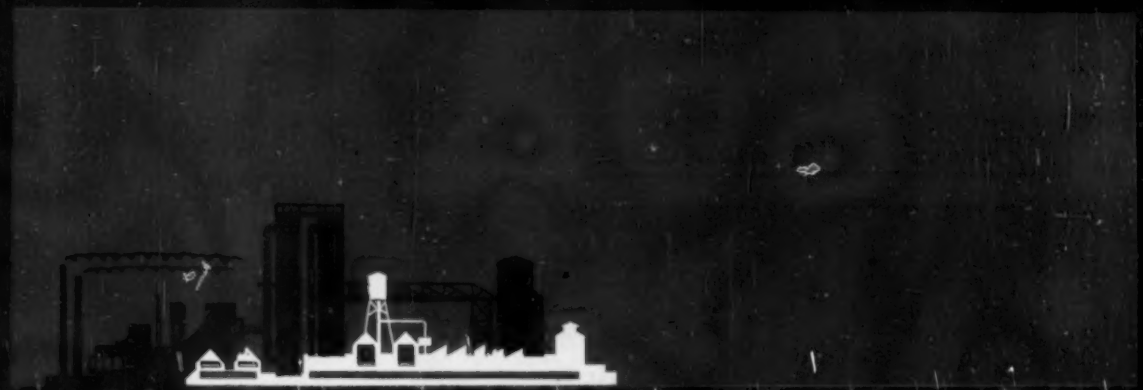
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With Systox. Without Systox.

# Double Threat Insecticide

**Newly-approved systemic attacks bugs in two ways: through the stomach; through the nervous system on contact. It often exhibits twice the impact of parathion.**

For the first time the U. S. Dept. of Agriculture has approved a systemic insecticide for use in this country. Called Systox, it has been okayed for use on cotton to control aphids and mites.

Pittsburgh Agricultural Chemical Co. are now making it commercially at Neville Island, Pittsburgh. And they expect USDA permission soon for use on such plants as roses, vegetables and tobacco. They also expect sales to exceed a million dollar volume.

The product is an organic phosphate ester—0,0-diethyll-0-2—(ethylmercapto)-ethyl thiophosphate. After being applied either to the foliage (as with cotton) or to the soil, it is absorbed and spreads throughout a treated plant by a physiological action called translocation.

It kills in two ways: as a stomach poison where it is sucked into the insect's digestive system; as a contact poison when it reaches the insect's nervous system.

PACC claims that it renders treated plants toxic to insects three or four times longer than conventional insecticides. Plant toxicity lasts until the enzymatic action within the plant breaks it down. Breakdown end products are harmless.

Rain cannot wash off or dilute Systox because it is absorbed into the plant. It is effective in small doses, even as small as one ounce of pure Systox in solution peracre in some cases. Field tests have shown that only two applications per season are required in many cases as compared to the usual five to ten spray applications of conventional insecticides.

It can be effectively applied to seeds before planting, giving protection to the young plants for some time. In general, it appears to concentrate in new growth which needs more protection. It seems harmless to insects preying on the aphids and mites and does not affect honey bees.

Because of the manner in which it works, Systox is said to be twice as effective as parathion in many cases. However it is no more hazardous for trained operators to handle.

It forms an emulsion in water and can be diluted to any desired strength. It is suitable for use in all power-operated ground and aircraft sprayers.

Cost to the cotton grower will be about $8 per yr. per acre according to present test results. Price is about $32 per gal. for the concentrate which contains 4 lb. of the pure chemical in an emulsifier.

Developed by Dr. Gerhard Schrader of Farbenfabriken Bayer, Germany, it was patented last October. Chemagro, a corporation jointly formed by the Pittsburgh company and Geary Chemical, has the U. S. license and the trade-marked name.

## Synthetic Elastomer

**Resistance to abrasion and heat suggests applications in protective coatings, wire and cable, mechanical goods.**

A pilot plant at Belle, W. Va., now produces chlorosulphonated polythene, a white, spongy matted compound. Called Hypalon S-2, it is made by treating polythene resin with chlorine and sulphur dioxide.

Blended with natural and synthetic rubbers it imparts resistance to ozone, abrasion and heat as well as greater stiffness. With these properties it combines good flex life.

It is unique among elastomers in that it does not require carbon black for reinforcement. Thus Hypalon compounds can be fabricated without color limitations.

One of its outstanding properties, complete resistance to ozone, contributes to weather durability of compounded and cured stocks. This constituent of the atmosphere is responsible for deterioration of natural and synthetic rubbers. For example, a compound of the elastomer used as a fabric coating suffered no loss whatever in toughness after two years' exposure in Florida.

Still in an early stage of development, Hypalon S-2 is said to offer opportunities to manufacturers of tire-tread stocks, white-sidewall tires, automotive weather-stripping and window channels, coated fabrics, wire and cable covering, protective coatings for rubber and many other products.

Although processed much like ordinary rubbers, the chemistry of this chlorosulphonated polythene is different. Accordingly, curing systems are quite different from those used with other elastomers.

The preferred compounding ingredients include a metal oxide curing agent, such as litharge or magnesia, an organic acid, an accelerator, and fillers as required. Other common rubber compounding ingredients such as softeners, extenders, antioxidants and the like are also used.

Hypalon is based on a polyethylene having an average molecular weight of about 20,000. It contains approximately one chlorine for each seven carbons, and one sulphonyl chloride group for every 90 carbons. By varying molecular weight and its distribution, chain branching, and the degree of crystallinity, a wide variety of derivative types may be prepared and some day offered commercially.—*Polychemicals Dept., E. I. du Pont de Nemours & Co., Wilmington 98, Del.*

## Low-Pressure Laminates

**Withstand continuous exposure to 500 deg. F., intermittent exposure to 900 deg.**

Low-pressure silicone-glass laminates excel organic resin bonded glass laminates, useful only at operating temperatures below 350 deg. F.

Physical and electrical properties of these materials are comparable to those of conventional high-pressure silicone-glass laminates molded at 1000 psi. or higher. Their mechanical strength is far superior to silicone-bonded moldings of chopped glass, mica or asbestos.

Finished laminates weigh less than aluminum or magnesium and are stronger than either at 500 deg. F. Smooth, non-porous and easily machined, they are said to be highly water repellent and resistant to most commonly used chemicals.

Laminating stocks may be preformed and used to prepare complex shapes either by bag molding or in light metal molds. Flat sections can be laminated in thicknesses ranging from 0.01 to 2 in.

The laminates are molded at pressures from 3 to 30 psi. of glass cloth and Dow Corning 2104—the only commercially available silicone resin with the necessary properties. The resin has a low initial viscosity at laminating temperature and a gel time which may be controlled by the addition of a catalyst.—*Dow Corning Corp., Midland, Mich.*

## Fuel Additive

**To increase potential output of desired grades of diesel fuel.**

As little as one-tenth of one percent, by volume, of a new ignition improver is said to bring many distillate heating oils within the cetane number range of commercial diesel fuels. Moreover, it is reported to improve the cetane number of all types of diesel fuels, regardless of crude source, refining technique, or sulphur content.

The compound consists of a mixture of primary amyl nitrates, which is blended into the finished fuel. Called DB-36 amyl nitrate, it is now available in sample quantities for evaluation by the oil industry.

Aim of the new product is to enable refiners to supply the required grades of diesel fuel in the needed quantities at low cost. Forecasts are that it will increase the flexibility of refining operations by eliminating or reducing the selective blending now often required to produce diesel fuel of the required ignition quality. It will permit the upgrading of some heating oil stocks for diesel fuel purposes and make possible the marketing of diesel fuels which have more uniform ignition quality.

Laboratory tests indicate that cetane numbers gained with the new compound are the equivalent of natural cetane numbers. This added ignition quality is retained during storage.—*Ethyl Corp., 100 Park Ave., New York 17, N. Y.*

**IN BRIEF—A capsulated listing of this month's newsworthy products**


| It's New . . . | It's Good For . . . | See Page . . . |
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| Synthetic Elastomer | Protective coatings, wire and cable | 230 |
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| Bomb Glass | Reducing explosion hazards in plant windows | 231 |
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| Synthetic Fiber | Acid, burn, stain, mold and insect resistance | 232 |
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**HOW TO REDUCE ONE EXPLOSION HAZARD**

**Any explosion or pressure wave will open this glass on its built-in plastic hinges. Pressure is released and there will be fewer fragments. To repair simply push sections together and fasten with a bolt or fiber washer. Already used by the government, the glass-plastic laminate appears to have wide potential application in the CPI. Outer layer is a sheet of glass, middle layer a partially segmented sheet of butyral plastic. Inner layer consists of four triangular pieces of glass, the central area edges of which register with the segmented edges of the plastic. Plastic layer extends beyond the glass edges, is bolted to window frame to serve as hinges.—Pittsburgh Plate Glass Co., 632 Duquesne Way, Pittsburgh, Pa.**

## Fire-Proof Coating

**For protection of all types of wood uprights.**

Failure to stay put has made many fire-retardent products ineffective on vertical wood surfaces, though satisfactory on horizontal surfaces. A new product called Fireplate contains a jelling agent to counteract this tendency to melt and migrate under high temperatures.

Fireplate's ingredients also include bituminous materials, fire-retardent chemicals, a non-flammable solvent, a plasticizer which in itself helps put out fire, asbestos which forms an incombustible mat over any surface to which the coating is applied. Heat decomposes the chemicals and fire-smothering gases are given off.

Thanks to the incombustible solvent, the coating is said to provide fire protection the moment it is applied. This, too is a new advantage. Most available fire-resistant coatings use inflammable solvents (because they are less expensive) and thus, until such a solvent has evaporated it may actually add a fire hazard to a coated surface.—*Zone Co., 917 North Main St., Fort Worth 6, Tex.*



## Fire Retardant

**Blow torch flame at 1,900 deg. F. draws new coating into protective blister for asphalt coated wall board.**

Tamco Laboratories, small paint manufacturer in Los Angeles, sees bigness looming ahead with a line of flame-resistant paints. Two new products are the basis for optimism: a flame-resistant outside paint, and a flame-resistant clear coating for wood.

Charles Talmadge, manager of Tamco and a 30-year veteran of the paint business, thinks that in these two products the company has something without real competition.

"There are other good flame-resistant inside paints," he says, "but to my knowledge no one else has an outside paint that just won't burn."

Talmadge's favorite trick with prospective customers is to paint a wood shingle on both sides with Tamcoat, leaving one end uncoated; he lights the uncoated end, uprights the single; when the fire reaches the coated portion, the flame goes out.

The clear coating is a varnish-like material that gives protection without discoloration, and has the same fire-killing properties as the paint.

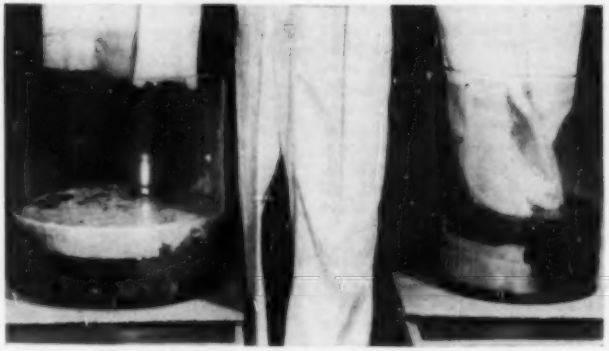
Chemical composition of the coatings is something Talmadge isn't talking about, beyond saying they aren't oil and they aren't rubber base. Water is used to wash up after the inside paint but cannot be used as a thinner; Tamco makes its own thinner. To tint the paint, which comes only in white, any coloring useable in a water paint is OK.

The outside coating can be thinned with turpentine or mineral spirits, and tinted with any coloring useable in oil paints.

In 20-min. fire tests by an independent laboratory, Tamcoat met the requirements of Federal Specification SS-A-118a, and it has also met the requirements of the California State Fire Prevention Code. In Tamco's own tests, the coatings have resisted blow-torch temperatures up 1,900 deg.

Though the company recommends two coats of Tamcoat (there is an undercoater for both inside and outside), it also gives its blessing to the use of Tamcoat outside paint over or under oil paint. It "tends to fireproof" a covering oil coat.

Tamcoat retails at $7.95 for outside coatings, $6.95 for inside.—*Tamco Laboratories, Compton, Calif.*



**DYNEL BEATS COTTON FOR CHEMICAL-RESISTANT CLOTHES**
(123A) **The chemical here is 60 percent sulphuric acid, the untouched trouser leg is of the new fabric. Workers handling corrosive chemicals are said to get 10 times more wear from dynel garments. Other advantages: burn, stain, mold and insect resistance. Other CPI applications: filter cloths and tubes, water softener bags. A dynel-wool dust fume bag, which filters hot acid particles from chimney discharges, has had exceptional industrial success.**

## Surface Active Agent

**Promising as an emulsion stabilizer, antifoam agent, mild antioxidant.**

Nonvolatile, cationic new surface active agent called Alkaterge-C is an amine-type compound. It reacts with mineral acids to form salts, some of which are water soluble and produce stable foams.

These salts of mineral acids or the salts of the lower monobasic organic acids or hydroxy acids are effective wetting agents. With the higher fatty acids Alkaterge-C forms oil-soluble soaps. The wetting power of these salts and soaps is frequently increased by the addition of alcohol or glycol.

Solutions of the salts have been used as penetrants in the textile and paper industries and in the formulation of metals cleaners. In the waterproofing of paper, salts of Alkaterge-C have been reported to reduce the consumption of resin in the impregnation of paper pulp in the beaters.

Its properties promise usefulness as an auxiliary emulsifying agent. Some data have been reported which indicate that it is useful in the preparation of water-in-oil emulsions. Also in oil-in-water emulsions Alkaterge-C or its soaps have been found to contribute to the stability of emulsions in the



# "Lift-up powder" for tired oil wells

*How Celite filtration helps boost oil output*

TO BOOST THE OUTPUT of "tired" oil wells bordering on the limit of economic production, profit-conscious operators inject water under extreme pressure into the porous oil sandstone and force out the accumulated oil. But first, they filter this repressurizing water with Celite* to remove the suspended solids which would eventually clog the microscopic pores of the sandstone, thus blocking the flow of water. *All waters contain at least a trace of these troublesome impurities.*

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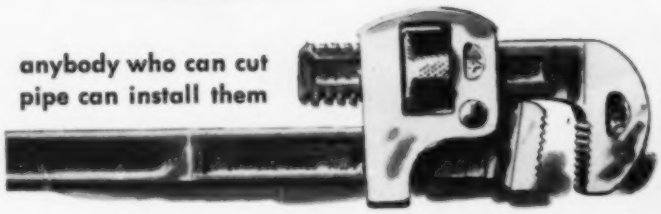
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presence of calcium and magnesium ions. They aid in the dispersion of the insoluble calcium and magnesium soaps.

The new product is useful in controlling certain types of foam encountered in processing organic materials. It is used either alone or in a suitable carrier such an animal, vegetable or mineral oil.

Mild antioxidant properties are indicated by the fact that 0.5 percent or more of Alkaterge-C in a drying oil tends to delay the drying of the film. It has been reported that the use of less than 1 percent in a hydraulic oil will reduce gum formation in the hydraulic system. This treated oil will clean a dirty system.—*Commercial Solvents Corp., 17 East 42nd St., New York 17, N. Y.*



### Plastic Coating

**Protects surfaces of light metal during handling. Adheres tightly, but to remove: lift corner and pull.**

A new plastic coating designed primarily for light metals has been developed jointly by Cellon Ltd., and Birmetals Ltd., both of England.

The coating forms a transparent flexible film which adheres to the surface of the metal. In addition to protecting the metal indefinitely, it is sufficiently tough and elastic to allow a polished sheet to be pressed before the coating is removed.

It is nonflammable, insoluble in gasoline, oil, water and many solvents; it has a high electrical resistance and is colorless when dry.

Possibly its most valuable application thus far is in protecting bright metals from the rolling mills through the various stages of handling, transport, fabrication, pressing and storage —that is, until the finished articles reaches the consumer. Also, by forming a cushion between the metal and the dies, the life of press tools is prolonged. This material is being used by some of the larger British manu-




## LUBRICANTS

Just stir these lubricants into water and they're ready to apply. When their work is done, remove them with a water rinse. No emulsifying or coupling agents are necessary to get them into solution and no costly alkalies or detergents are needed to remove them.

As rubber mold lubricants they give quick, clean release from the mold and impart an attractive finish to the rubber. And they burn out almost completely during the fabricating cycle without excessive carbon build-up.

In textile processing sizes, their lubricating and softening action gives the size pliability and lubricity. As a finishing size CARBOWAX compounds impart a soft "hand" to cotton and viscose and acetate rayon.

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Besides their lubricating action and water-solubility, CARBOWAX compounds have the advantage of being white in color, bland and non-irritating to the skin, and solvents for many medicaments. These properties have made them popular as ointment bases for drugs and cosmetics. Their water-solubility insures effective action by the medicaments and complete coverage of tissue areas, as well as easy removal.

In cosmetic creams and lotions, CARBOWAX compounds impart skin-smoothing properties without a moist or tacky feeling and can be removed easily between applications.

*Other uses of these unusual products include: metal extrusion operations, lubricants and humectants in steam-set inks, water-soluble bases for decalcomanias, plasticizers in adhesives, solvents in fire-fighting foams, binders for ceramic colors, additives in tin-plating solutions, and intermediates for the preparation of non-ionic surface-active agents and resins.*

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facturers of polished aluminum sheet. On account of the shortage of the raw materials from which the product is made, supplies have been pretty much restricted to use on metals for export.

Called Birlon, the new coating is applied by spray or roller—preferably the latter—under controlled conditions of heat and humidity. A film of 0.001 to 0.002 in. is recommended, according to the purpose for which it is intended. It air-dries in 20 to 30 min. and is said to have an extremely high tensile strength, coupled with great elasticity. It adheres tightly to the surface of the metal, like a thin skin. But it can be removed very easily, without the use of solvents, by merely lifting a corner and pulling it off in a matter of seconds.—*Cellon Ltd., Kingston-on-Thames, England; Birmetals Ltd., Quinton, Birmingham, England.*



### Silicone-Fiberglas

**Forms simple and complex shapes with temperature, age and chemical resistance.**

ArcoSil 2184 is the most recent of a line of silicone rubber impregnated Fiberglas materials developed to meet the need for ducting, sleeves and couplings with resistance to high and low temperature. The material combines a newly developed silicone rubber compound with improved fabrication techniques which result in a superior product at a lower cost.

Items manufactured by Arrowhead from ArcoSil 2184 withstand temperatures as high as 700 deg. F, remain flexible at −125 deg.; resist aging, ozone and most corrosive fluids and gases. The new silicone rubber compound used is said to be several times more resistant to abrasion than any previous silicone rubber material.

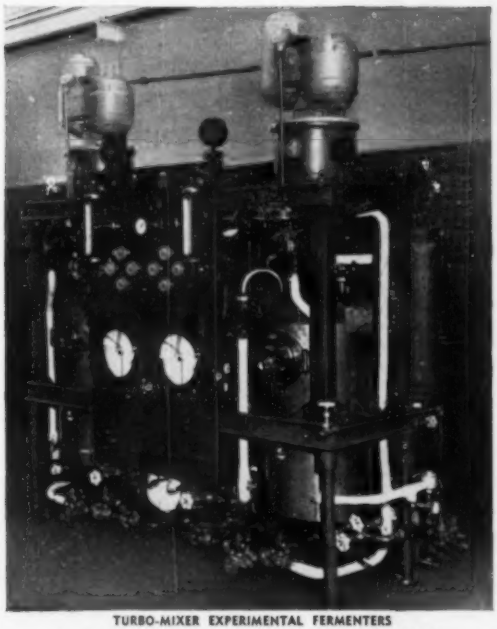
An important charactertistic of the new material is that it lends itself more readily to the forming of both simple and complex shapes. This has made possible new and improved fabrication methods which result in a substantial reduction in cost of items

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made from ArcoSil 2184, compared with previously used silicone-Fiberglas materials. In addition, ducts fabricated from the new material have less leakage.

Items now in production and available as standard and custom-made parts include helical wire supported flexible ducting and tubing in all diameters for high and low pressure applications, convoluted and sleeve-type flexible couplings for hot air ducts, high pressure-high temperature hose suitable for handling hot air at 700 deg. F and 2,000 psi., die-cut high temperature gaskets, and fabric-covered sponged silicone seals for high and low temperature sealing applications. The material can be bonded to metal and parts can be fabricated with built-in T's, elbows, flanges and other special features.—*Arrowhead Rubber Co., Downey, Calif.*

## Anti-Static Agent

**For acetate, rayon, nylon and the newer synthetics.**

One chemical provides in a single application two-way treatment: gelatine sizing, warp softening.

Added in amounts of from 8 to 16 lb. to 100 gal. of gelatine size mix, the new anti-static agent has effected the following results in slashing and weaving applications made thus far. Warp ends did not stick to the drying cans, split easier at the splitting bars and showed less broken ends. Warps were woven with less shiners, shedding and breakage and loom efficiency and fabric appearance was greatly improved.

The new product, called Lektrostat Gy, will also work with anionics under normal conditions. Its use has shown no effect upon the shade of whites, nor has it affected the lightfastness of the colors.—*Dexter Chemical Corp., Blvd. P.O. Box 1, New York 59, N. Y.*

## Copolymer

**Potential uses in paper coatings, adhesives, inks, lacquers.**

Developed primarily for the paper industry, a new polyvinyl acetate copolymer solution deposits films with non-blocking characteristics, Pressure tests of one pound per square inch at 120 deg. F. and at a relative humidity of 78 percent show no evidence of face-to-face blocking.

The films are also said to be tough, glossy, scuff resistant, water and grease resistant and heat sealable. In addition to paper coatings, other prom-

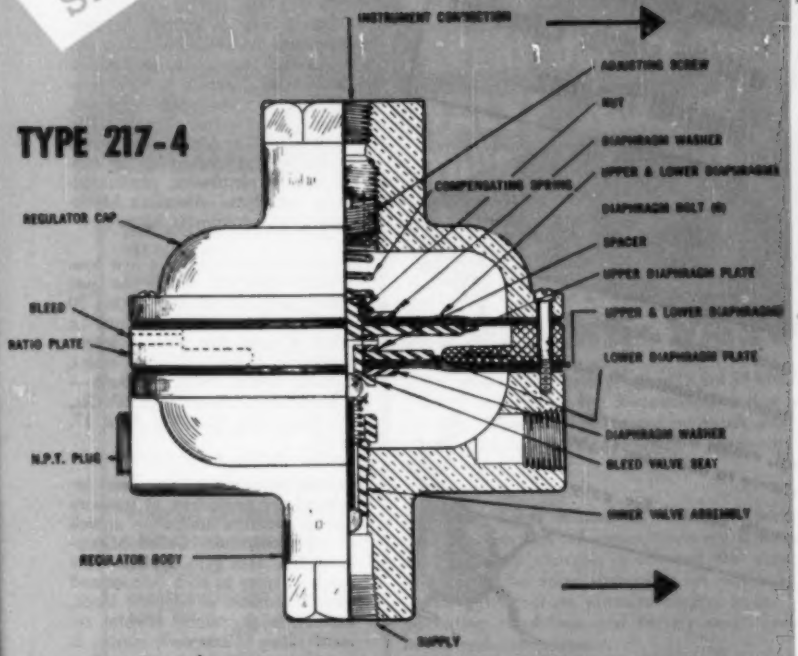
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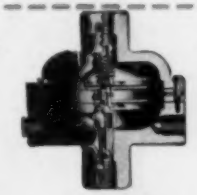
**BLACK, SIVALLS & BRYSON, INC.**

*Climax Controls Division Dept. 4-N6*

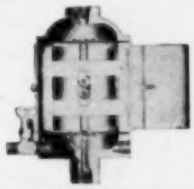
7500 East 12th St. Kansas City 3, Missouri



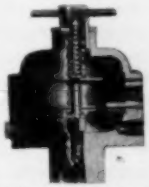
NEW TYPE 227 **Delayed action, fixed ratio.** Permits full valve travel with standard diaphragm pressure ranges on series-operating diaphragm control valves in combination with type 217-2B relay.



TYPE 217 **Fixed Ratio**—to meet demands of control pressures beyond the range of usual instrument pressures; permits low-limit controls to secure higher loading pressure.



TYPE 224 **Variable Ratio**—creates a loading of pressure balanced diaphragm valves to permit the control of high steam pressures in reboilers or fractionating kettles, where steam pressures must vary for varying products.

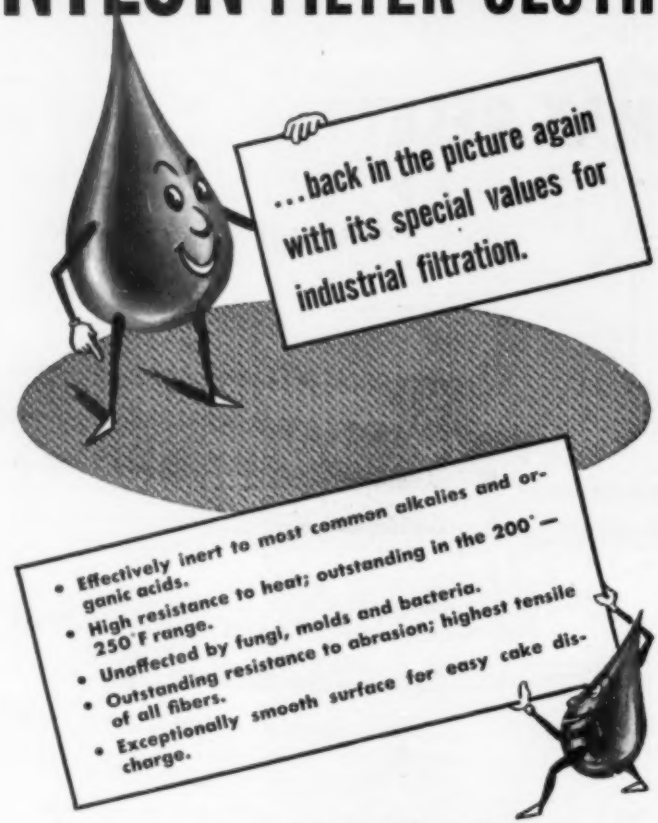


NEW TYPE 228 **Reverse Action Relay** for maximum pressure output at minimum input—or vice versa. Or, in bypass installation, reverse valve action in relation to pilot action, when occasionally required.



TYPE 209 **1 to 1 Ratio**—will eliminate air exhaust and input pressure lag where long supply medium lines are used.

# NYLON FILTER CLOTH




Under severe caustic conditions, at high temperatures, NYLON filter cloth has outlasted cotton cloth by as much as 15 times. Similarly, in neutral solutions where tensile strength and abrasion resistance are controlling factors, our NYLON cloth has outworn, outperformed cotton 4 to 5 times.

For production purposes we can supply you with NYLON filter cloth woven on our looms . . . a wide range of weaves and weights. Standard widths are available without quantity limitation; special widths can be made to order in as little as 100 yard lots.

We recommend NYLON filter cloth for better, more economical filtration in many process industries. Write for full details and samples — put NYLON to work saving dollars in your Plant.

*Weavers of Industrial Filter Media for over Forty Years*

NFM **The National Filter Media Corp.**

General Offices & Mills: New Haven 14, Conn.
Western Office & Factory: Salt Lake City 1, Utah

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| Chicago, Ill. | Cincinnati, Ohio | Houston, Texas | Oslo, Norway | Johannesburg, South Africa |
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| 2627 West 19th St. | Dexelown Center Bldg. | 1406 Second National Bank Bldg. | Nicolai Feits | Edward L. Bateman |




ising applications are in adhesives, inks, lacquers and protective coatings, saturants and sizings.

Called Polyco 408, it can be reduced to a solids content of 45 percent with ethyl alcohol without causing precipitation of the copolymer. It is soluble in all proportions with ethyl acetate and acetone.—*American Polymer Corp., Peabody, Mass.*

**Monomer,** n-butyl acrylate, is now commercially available from this company. It is useful in the production of polymers and copolymers for low temperature rubbers, adhesives, protective coatings. The reactivity of the double bond makes it a good intermediate in the production of plasticizers, pharmaceuticals and dyes.—*American Monomer Corp., Leominster, Mass.*

**Dimethylethanolamine** in a new low-priced, industrial grade has just been put on the market. It is a 70 percent solution of the amine in water to meet the needs of manufacturers of ion exchange resins, wetting agents, textile assistants.—*Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.*

**One-coat, oil base paint** has been developed for protection of masonry against moisture infiltration as well as for decoration. Called Mason-Coat No. 310, it is applicable by brush or spray to both interior and exterior surfaces of concrete block, cement, brick, stucco, asbestos cement siding. Extremely elastic, it is said to withstand severe weather and temperature changes.—*United Laboratories, Inc., Cleveland, Ohio.*



**PUBLICIZED TB-FIGHTER**

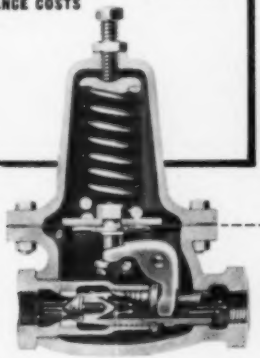
**Here's a close-up of isonicotinic acid hydrazide, highly publicized new anti-TB drug. Medical institutions are, so far, willing to treat hopeless cases only with it. Not yet commercially produced, it is still far cheaper to use than time-tested streptomycin or PAS—Panray Corp., 340 Canal St., New York, N. Y.**



# Check

## EVERY ONE OF THESE VALVE *Benefits* IN YOUR OWN PLANT . . .

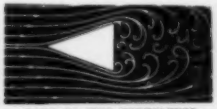
- MAXIMUM CAPACITY WHEN NEEDED MOST
- ACCURATE PRESSURE CONTROL UNDER TOUGHEST WORKING CONDITIONS
- TROUBLE-FREE SERVICE
- SMOOTH OPERATION
- TIGHT CLOSURE
- ACCURATE REGULATION
- SPEEDIER PRODUCTION RESULTS
- ELIMINATION OF FAILURES
- CONSTANT DELIVERY PRESSURE
- COST SAVING OPERATION
- NO SPOILAGE
- PRACTICALLY ZERO IN MAINTENANCE COSTS



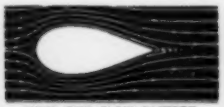
## CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVE

There's much more ability in the CASH STANDARD "1000" because of the Streamlined design which has eliminated small ports and passages and complicated mechanism and in which there are but few close fitting parts.

Streamlined flow around the inner valve means no trouble from lack of capacity—even under peak load or sharp changes in demand the aspirating effect gets the valve wide open for maximum flow—you get accurate pressure control under tough operating conditions and there's never variation in the reduced pressure.



NONE OF THIS TURBULENCE



GIVES THIS FLOW PATTERN

***If you want full details on the STREAMLINED "1000" Valve, send for bulletin 1000.***

Get details on the performance of this "Streamlined" 1000 Valve that insures maximum capacity—close delivery pressure control, and saves operating and maintenance costs.

☆

CASH STANDARD CONTROLS.. VALVES

**A. W. CASH COMPANY**
DECATUR, ILLINOIS

**BULLETINS AVAILABLE ON OTHER CASH STANDARD VALVES**
***Send for them***



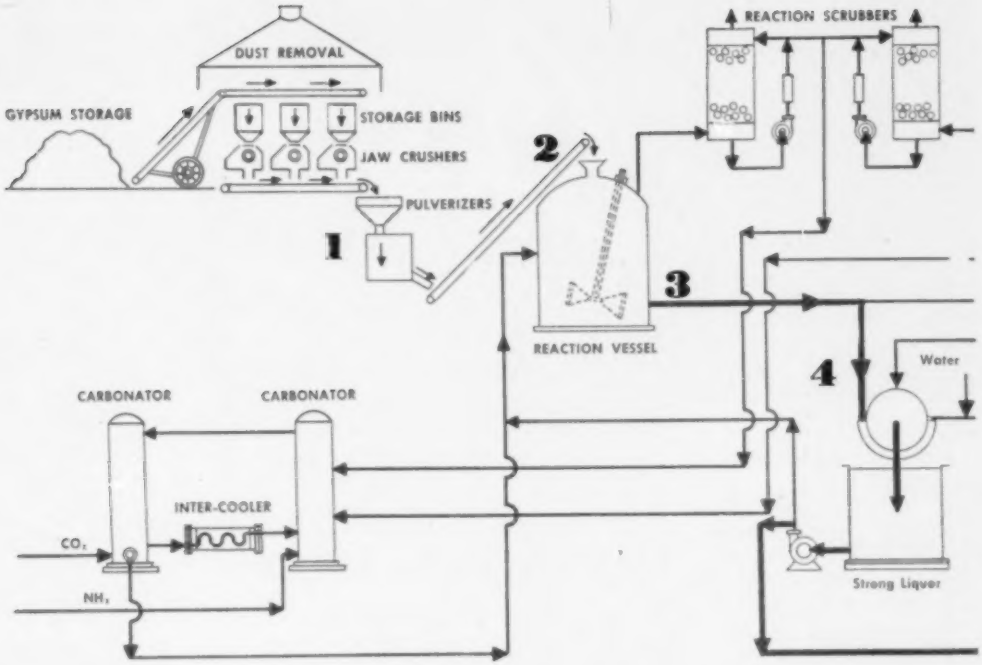
Bulletin 963 features the CASH STANDARD Type 100 Series of Super-Sensitive Controllers — various types for automatically operating valves, dampers, rheostats, stokers, pulverizers, fans, and other apparatus. 16 pages filled with descriptions and applications.



Bulletin 968 features the CASH STANDARD Type 34 Pressure Reducing Valve — direct operated — direct acting for handling steam, hot water, cold water, air, oil, brine—and most liquids and gases except some injurious chemicals. Illustrates and describes the different styles available and tells about their applications. Three pages of capacity charts.



Bulletin 956 features the CASH STANDARD Type 4030 Back Pressure Valve — designed to automatically maintain a constant pressure in the evaporator corresponding to a constant temperature desired. Shows an Ammonia and Freon Gas Capacity Chart based on ABSOLUTE pressures.




# Ammonium Sulphate From Gypsum

Recently completed, the $50 million ammonium sulphate plant at Sindri, Bihar, India, will go a long way towards supplying this country with the artificial fertilizers it so critically needs. When in full operation, the plant will produce more than 350,000 tons per year, or about one seventh the nations fertilizer needs. Principal raw materials are gypsum and coke.

Basic design was done by Imperial Chemical Industries, with Chemical Construction Corp. (American Cyanamid subsidiary) doing much of the design and supervision of construction for the Government of India.

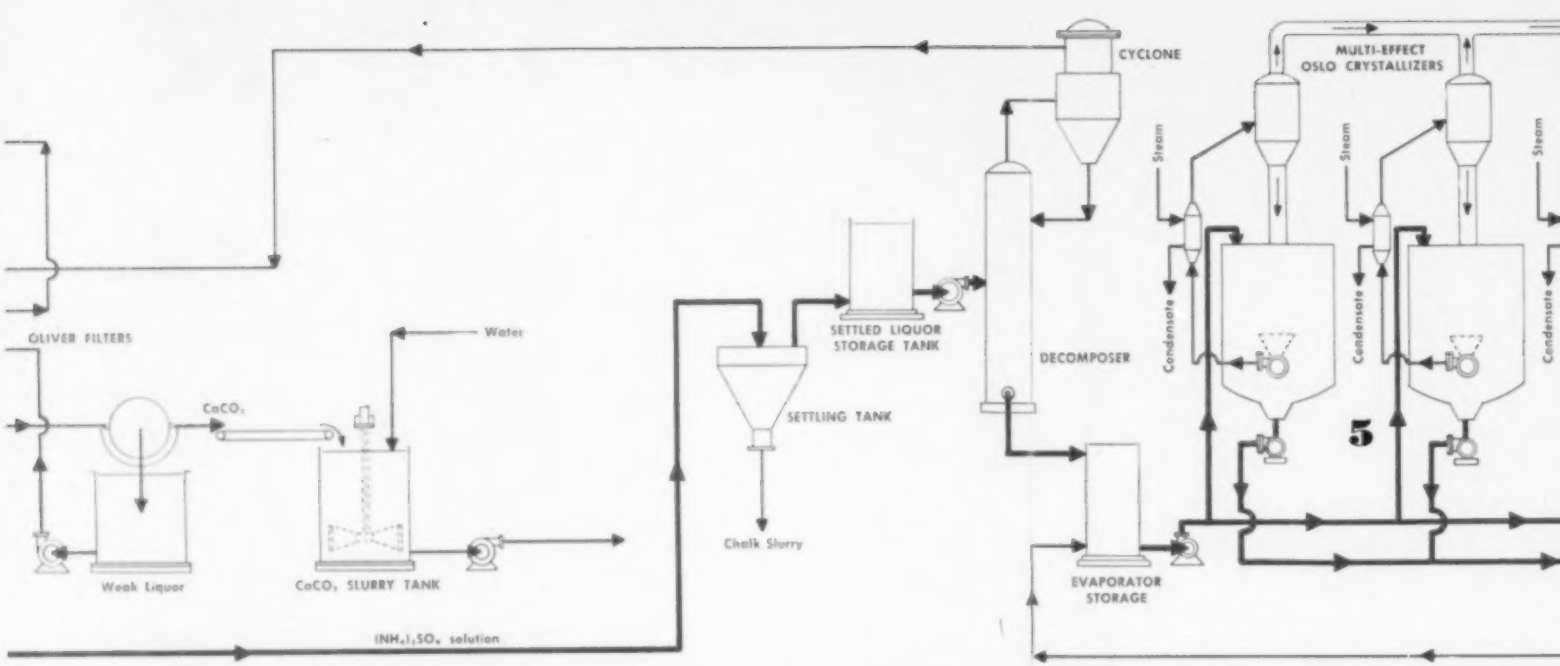
The design provides for eventual expansion that will double the output, and for selective expansion to produce numerous additional chemicals which could be used as raw materials by other chemical plants. Additional projects now being considered by the government include facilities for production of ammonium nitrate, urea, methanol, formaldehyde and other products. A phosphatic fertilizer plant nearby would use some of the intermediates to be produced. Planned also is a plant to utilize the byproduct, calcium carbonate, for the production of 300 tons per day of high quality portland cement.

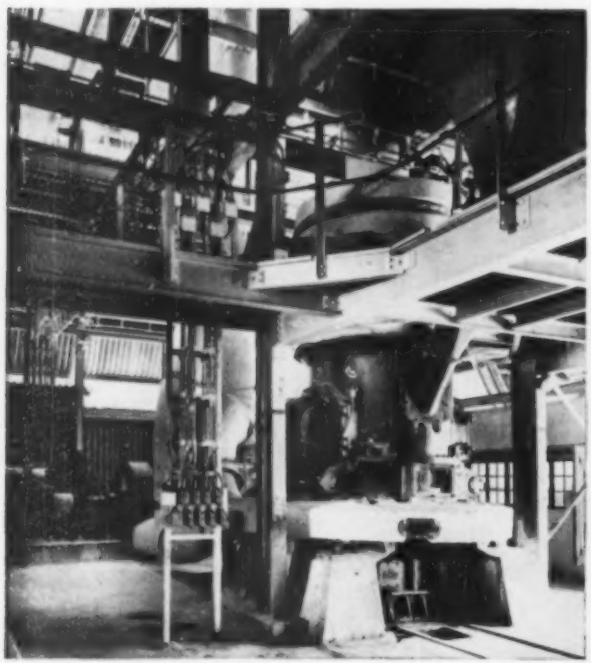
The Sindri plant consists of an 80,000 kw. power generating station (of which 3,600 kw. will be used for the fertilizer plant and the remainder for the Bihar grid), a gas plant which will generate 33 million cu. ft of hydrogen and nitrogen, an ammonia synthesis plant where the two gases are combined to produce 300 tons of anhydrous ammonia per day, and the sulphate plant described on the adjoining flowsheet.

In the gas plant, a semi-water gas is produced from coke, steam and air. The carbon monoxide is converted to carbon dioxide and removed for use in the process, leaving ammonia synthesis gas. Ammonium carbonate solution from the reaction of carbon dioxide and ammonia is reacted with gypsum to form the ammonium sulphate and calcium carbonate byproduct.

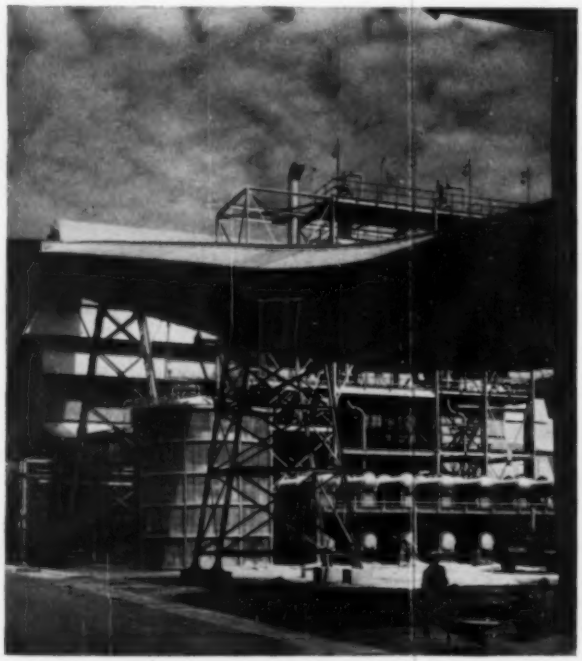
Associated with the new plant is a complete township constructed by the Indian Government and a nearby Engineering College established by the State Government of Bihar. The College, which operates in close association with the plant, offers courses in chemical, mechanical and electrical engineering.

With both the plant and college in operation, it is possible for the first time for substantial numbers of Indian nationals to receive complete training in their own nation in chemical engineering, power house engineering and heavy plant maintenance.

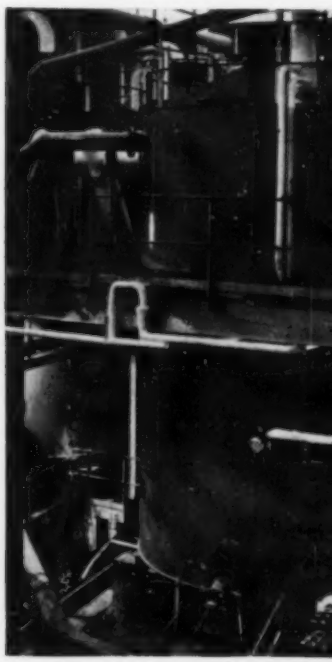


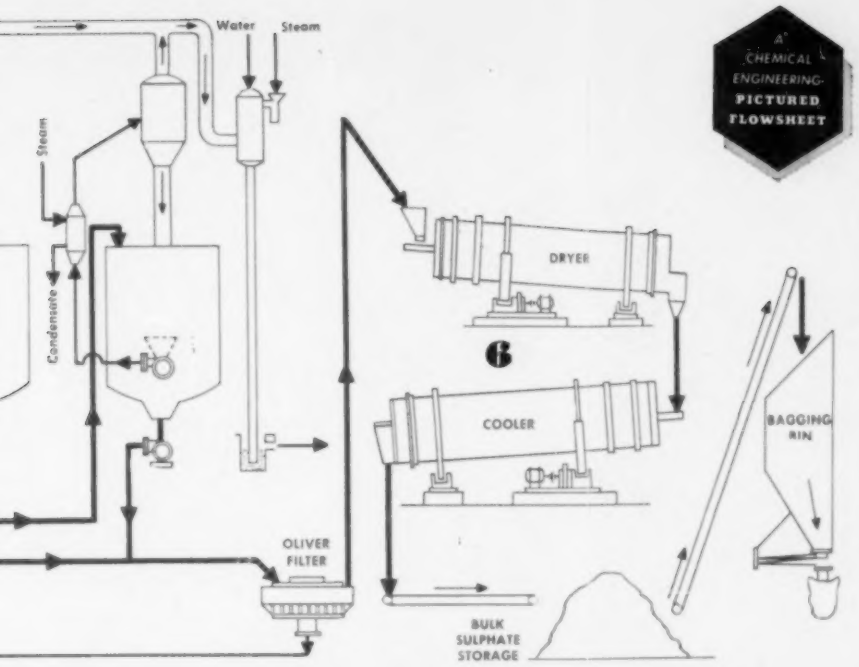
**1** Pulverizer takes gypsum which has been put through jaw crushers and reduces it to size for reaction.

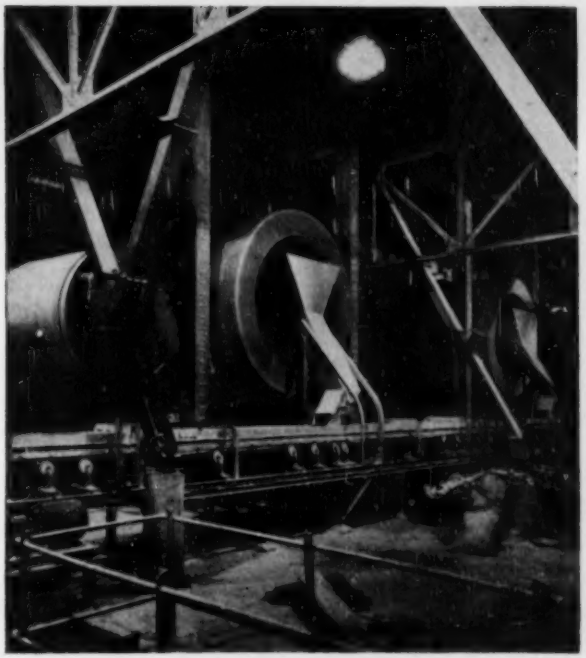


**2** Conveyor carries ground gypsum from grinding to reaction plant. Horizontal tanks are liquor coolers.



**3** Reactors where carbonated liquor and ammonium sulphate and calcium carbo

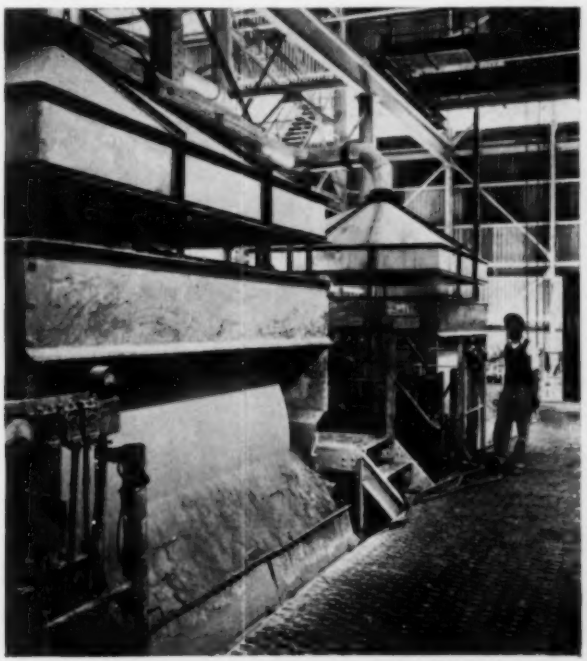


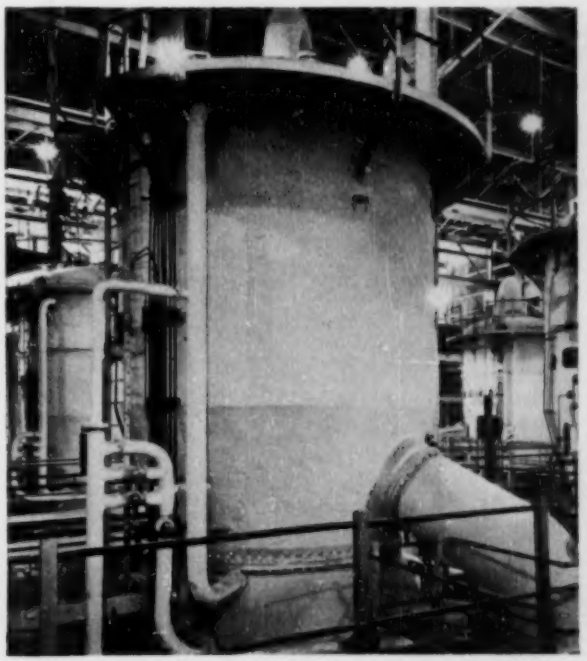
**6** Coolers for ammonium sulphate crystals which have been previously dried. Discharge is to conveyor belt.



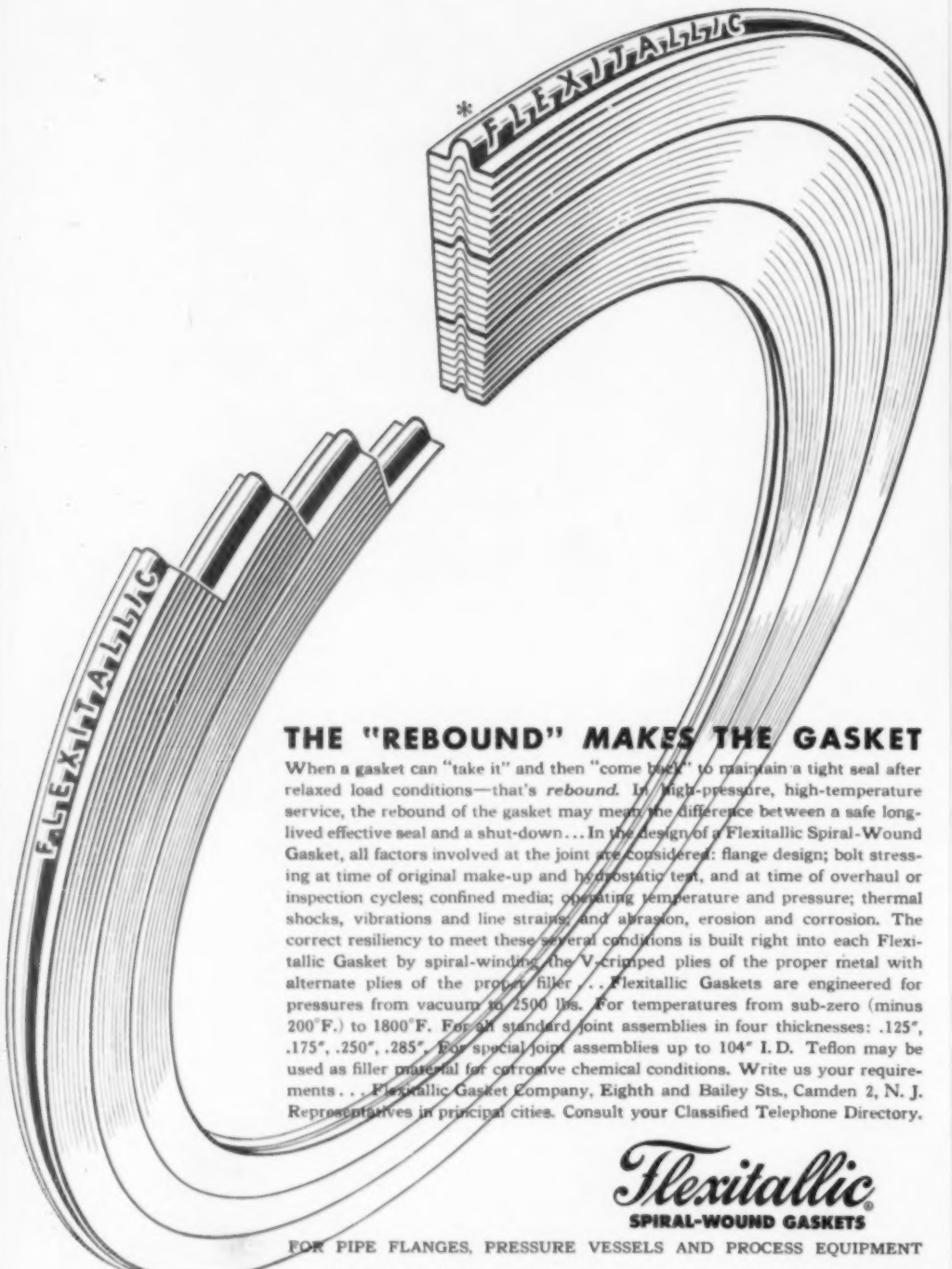
nor and ground gypsum react to produce m carbonate.



**4** These filters separate chalk from ammonium sulphate. (The chalk is transferred to outdoor storage.)



**5** Evaporators where ammonium sulphate is crystallized by evaporation of water. Salt filter is below.




## THE "REBOUND" *MAKES* THE GASKET

When a gasket can "take it" and then "come back" to maintain a tight seal after relaxed load conditions—that's *rebound.* In high-pressure, high-temperature service, the rebound of the gasket may mean the difference between a safe long-lived effective seal and a shut-down... In the design of a Flexitallic Spiral-Wound Gasket, all factors involved at the joint are considered: flange design; bolt stressing at time of original make-up and hydrostatic test, and at time of overhaul or inspection cycles; confined media; operating temperature and pressure; thermal shocks, vibrations and line strains; and abrasion, erosion and corrosion. The correct resiliency to meet these several conditions is built right into each Flexitallic Gasket by spiral-winding the V-crimped plies of the proper metal with alternate plies of the proper filler... Flexitallic Gaskets are engineered for pressures from vacuum to 2500 lbs. For temperatures from sub-zero (minus 200°F.) to 1800°F. For all standard joint assemblies in four thicknesses: .125", .175", .250", .285". For special joint assemblies up to 104" I.D. Teflon may be used as filler material for corrosive chemical conditions. Write us your requirements... Flexitallic Gasket Company, Eighth and Bailey Sts., Camden 2, N. J. Representatives in principal cities. Consult your Classified Telephone Directory.

**Flexitallic**
**SPIRAL-WOUND GASKETS**

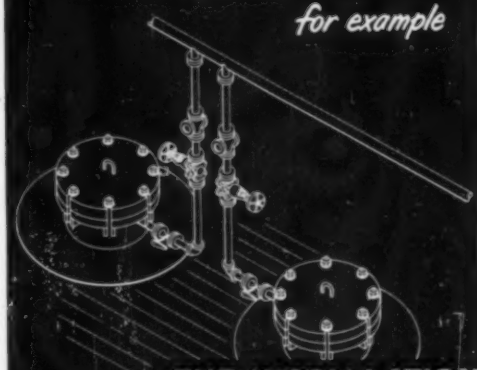
FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* in gaskets with asbestos filler.



# Do Your Valves Res
## Like This?

... on Digester Gases, for example




VAL

CORRO
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AVAIL
Reg

Crane Alloy Plug Gate Valves on sulphate digester gas-off service in a large Southern paper mill.

### THE HISTORY

Valves in this installation are used to relieve, under throttled flow, the highly corrosive sulphate gases from digesters. Various valves tried gave constant trouble with corrosion, leakage, and difficult operation. Replacements were excessive.

Then Crane 18-8 Mo Alloy Plug Gate Valves were installed on a test basis. After 1 year's service, and again after 2, careful inspection showed hardly a sign of wear or corrosive effects. Meanwhile, the valves operated smoothly; required no maintenance.

So well have Crane valves out-performed and outlasted all others tried, they have been made standard equipment on all digesters.

THE

One of the
for severe co
Gate—with
parts expos
gland. Circu
minimum r
cise control
sign throug
Also in All-
log or Cran

*The Complete Crane Line Meets All Valve Needs. That's Why*
**More Crane Valves Are Used Than Any Other**

# CRANE VALV

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago
*Branches and Wholesalers Serving All Industrial Area*

**VALVES • FITTINGS • PIPE • PLUMBING**

# esist Corrosion

VALVE SERVICE RATINGS

| | |
|---|---|
| CORROSION-RESISTANCE: | Best results ever had |
| FEATURES: | Plug seating-good for throttling and wide open service |
| SUITABILITY: | Adopted as standard |
| MAINTENANCE COST: | No upkeep needed |
| SERVICE LIFE: | Hardly any wear after 2 years |
| OPERATING RESULTS: | Better control of digester gases |
| AVAILABILITY: | Regular Crane Catalog item |

THE VALVE

e of the leaders in the Crane Alloy line severe corrosive service—No. 18851 Plug e—with 18-8 Mo stainless steel in all ts exposed to flow, including packing nd. Circular, tapered plug seating gives imum resistance to flow; allows pre- control when throttling. Superior de- n throughout. Flanged or screwed ends. o in All-Monel. See your Crane Cata- or Crane Representative for full data.



Other Make!

LVES

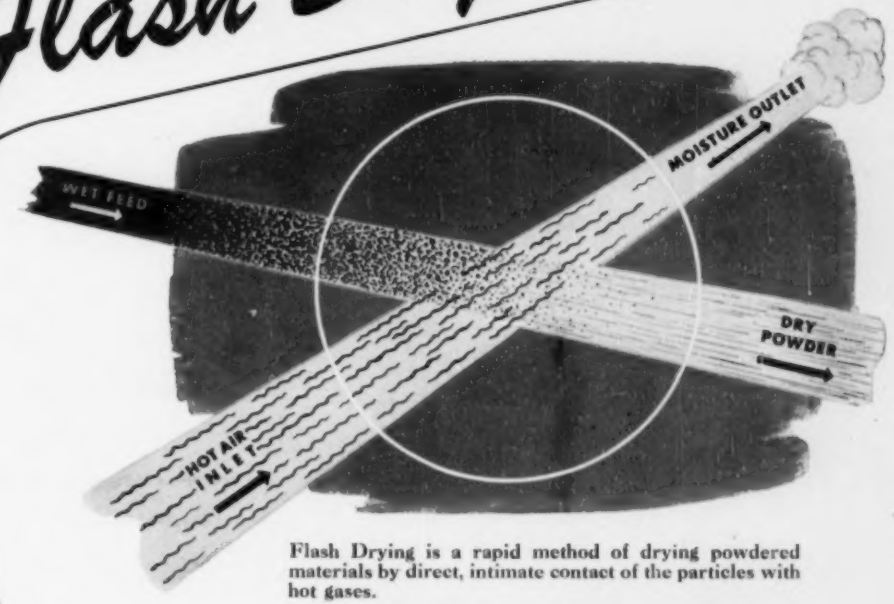
, Chicago 5, Illinois
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MBING • HEATING





# WHAT IS *Flash Drying?*




RAYMOND
Flash Drying
CATALOG
No. 54A

For detailed information on Flash Drying Systems write for Catalog No. 54-A.

Flash Drying is a rapid method of drying powdered materials by direct, intimate contact of the particles with hot gases.

The wet material is dispersed in a hot air-stream, causing instantaneous removal of moisture from the fine material. Drying is accomplished in a few seconds which results in a superior product that cannot be obtained on dryers having a longer time element.

Due to the short process time, high inlet temperatures can be used, insuring maximum heat efficiencies. The complete plant is also greatly simplified, requiring less floor space which means low first cost. Flash Drying Systems have low-power requirements and provide for close control of final moisture and particle size.

Raymond Flash Drying Units are available with various types and sizes of Raymond Mills. When handling solid materials, both drying and grinding may be required. For such materials as filter cakes, disintegration only may be necessary.

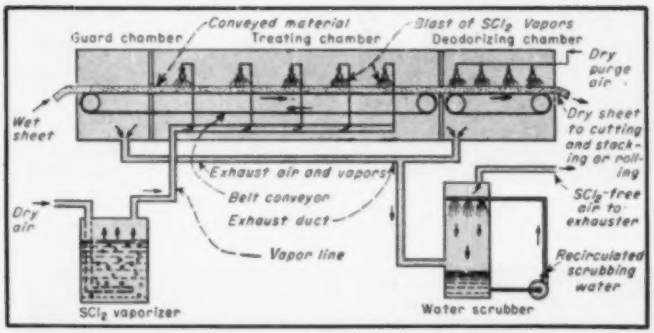
Raymond engineers will be glad to recommend a system designed to fit your product specifications and capacity requirements.

**COMBUSTION ENGINEERING – SUPERHEATER, INC.**

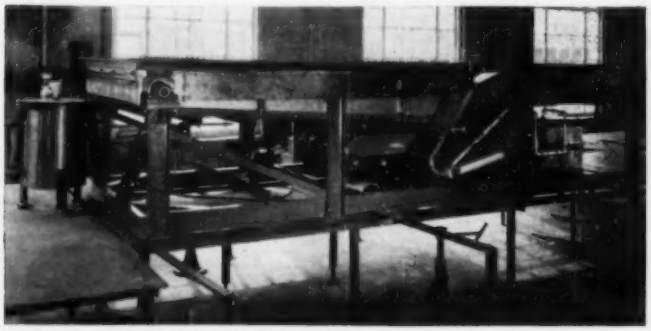
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Chicago 22, Illinois

*Raymond*
PULVERIZER DIVISION

Sales Office in
Principal Cities




PROCESS hinges on blasting the coated material with sulphur dichloride vapors.



EQUIPMENT, as shown by model here, is simple and compact because of fast reaction.

# Quicker Way to Dry Coatings

**New technique — now available to industry — drys protective and decorative coatings in a matter of seconds. Nub of the trick is to use sulphur dichloride vapors.**

Cost-conscious engineers in the coatings field now have something new to try out: a radically different process for drying—and drying fast—their protective or decorative coatings of ink, paint or varnish.

The new technique—now being offered to industry for the first time—is known as the Chem-Dry process. It promises to dry or harden completely certain kinds of drying oils and resins in a matter of seconds instead of minutes or, in some cases, hours.

Meyercord Co. of Chicago, who developed the process, has now named H. L. Barnebey* of Chemical Processes, Pittsburgh, as exclusive licensing agent. This culminates an extensive development program carried out over a period of years.

▶**Real Speed-Up**—Current high interest in the Chem-Dry process centers around the fact that it dries or hardens by an entirely new method: chemical reaction rather than by polymerization or evaporation of solvents. The chemical agent is sulphur dichloride vapors.

By this technique, Barnebey points out, it takes only a few seconds to harden inks, paints and varnishes whether they are coated on paper, cloth, metal, wood, glass or plastics. Heavy coatings can be put on and yet the coated material can be stacked, rolled or packaged directly from the machine.

This speed-up in drying, of course, offers real possibilities for cutting operating and labor costs in many plants. In some operations the hardening step, long a troublesome bottleneck, can now be paced so that other operations no longer need be slowed down.

In the case of ink compositions based on alkylated resins, for example, researchers C. E. Thorp and L. C. Kinney (who did most of the early research work at Armour Institute) found that the reaction with sulphur dichloride would give a hard, tack-free film in less than 10 sec. This held for both urea and alkyd modified melamine resins. Even with semi-drying and non-drying oil compositions, a film with only slight tack could be formed in less than 20 sec.

▶**Simple Process**—Both process and equipment for the Chem-Dry method are simple (see cuts).

Dry vapors of sulphur dichloride, generated by passing low-pressure air through liquid dichloride, are blasted or sprayed onto the coated side of the material as it passes quickly through the treating chamber on an endless belt conveyor.

What happens is a fast—almost instantaneous—chemical reaction between sulphur dichloride and the oil. With unsaturated oils such as tung and linseed, the dichloride probably causes polymerization by acting on the double bond. With unsaturated compounds, it probably takes the place of a hydrogen atom in the hydrocarbon.

In either case, the chemical reaction gives a relatively dry, non-tacky, hard film or deposit within about 2-10 sec. for unsaturated hydrocarbons and 30 sec. or less for saturated compounds. Under normal conditions, this takes place while the coated material travels only 2-15 ft. Abnormally thick coatings, of course, require more time than thin ones.

Since residual dichloride vapors might damage the material, these are removed promptly in the deodorizing chamber. Here blasts of dry air flush off the vapors, which are then passed through a water scrubber. Water breaks down the chloride into hydrogen chloride and colloidal sulphur; hence exhausted air is free of any dichloride vapors.

* Formerly head of Blaw-Knox's chemical plants division. The Chem-Dry process is covered by U. S. patents 2,528,850 and 2,544,839 and by pending applications.

The hardened coating, now dry and free of dichloride vapors, passes out of the machine continuously. It can now be rolled, cut and stacked or packaged without sticking or "offsetting."

► **Plus-and-Minus** – The Chem-Dry technique, simple in principle and plant operation, needs no heat or solvents. The equipment takes up less space than most other methods.

Costs, too, should be less. And as Barnebey points out, the fast, flexible and continuous nature of the operation might even make it possible to manufacture some products not otherwise feasible or economical.

There seems, however, to be one fly in the ointment: the Chem-Dry technique is not suitable for certain processes—such as manufacture of decalcomania—that require humidity control within the equipment to get exact register for many coatings on sheets of large size.

Meyercord Co. found this out when it tried to use its new process in its own decalcomania operations. Even though the project was started with this use in mind, the Meyercord people immediately saw the wider possibilities. President Leonard H. Knopf became personally interested, placed commercial application work under the direct supervision of Jess Klopfenstein.

► **Open Fields**—Working closely together, Klopfenstein and Barnebey began to uncover possibilities outside the decalcomania field. It is these that is now stirring up industry's keen interest in the Chem-Dry process.

Oilcloth, just to take one example, is now made by applying three or four coatings of a drying oil mixture, then polymerizing each of these by subjecting the material to a high temperature for a long time. This process, expensive and requiring a large plant investment, might well be done in a shorter time and at less cost by Chem-Dry methods.

In certain types of printing operations where heavy coatings are used, it is often necessary to keep the printed sheets on racks for 24 hr. or more before the coating is dry enough for handling. But in the Chem-Dry process, Barnebey stresses, the reaction is complete in a few seconds (usually less than 10, even for heavy coatings) and can be carried out in a continuous machine of reasonable length.

Other possibilities of the Chem-Dry process run the gamut of the protective and decorative coatings field: artificial leather, coated leathers, corrosion resistant linings and coatings, linoleum, glass-bottle printing, appliances such as washing machines and refrigerators.



**1** First, air is drawn into upper plenum chamber, passes through grate. . .



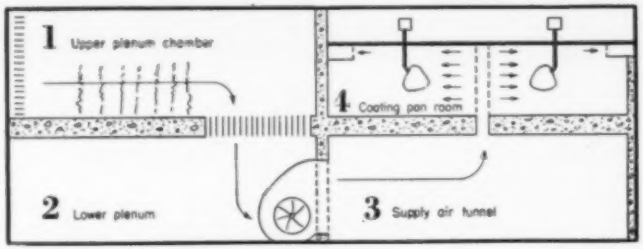
**4** Behind the coating pans (right), across the room to the exit ducts (left).



**2** Then down into the lower plenum chamber from which it circulates. . .



**3** Through the supply air tunnel. From here it goes up and out. . .




# Air Wall Solves Dust Hazard

**An unusual problem gives way to a unique system of air circulation in a pharmaceutical plant, effectively solves 150-year-old dust control problem.**

If you have to deal with concentrations of fine dusts in small areas, you might profit from the experience of White Laboratories, Inc., a New Jersey pharmaceutical firm.

White's problem was in its coating rooms where tablets are coated with medicinal agents, flavoring and other materials.

The coating process takes place in large, rotating pans (see cut) into which air is blown at controlled temperatures and humidity. As the material dries, a part of it is carried out of the pans in the form of very fine dust and the air soon has a heavy concentration of these particles.

These conditions meant four distinct problems: (1) the irritating effect of some coating materials on the

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mucous membranes of operators working in the room; (2) the risk of dust explosions; (3) additional discomfort to employees resulting from the 50-deg. F. temperature of the air blast directed on the pans and the relative humidity of 65 percent; and (4) the need to prevent contamination of one medicinal ingredient by another in the form of airborne dust.

▶**Nine Failures**—White Laboratories had spent more than $150,000 in nine different attempts to correct the problem—all without success. Other companies' efforts had been similarly fruitless. It looked like the solution—if there was one—would have to come from a unique system of air conditioning rather than from any change in the coating technique.

A. M. Kinney, Inc., Cincinnati consulting engineers who designed the plant, thought that the way to lick all four problems was by pushing air through a grated wall area (behind the coating pans) in large enough volume to create a positive air movement across the room. They reasoned that this cross-current would carry with it the minute particles blown out of the pans. Then, by exhausting the dust-laden air at the opposite wall, the atmosphere could be kept clean. Thorough study confirmed all conclusions and an experimental installation was made in White's plant at Newark, N. J.

A few months ago, the company moved into a new $3 million plant at Kenilworth, N. J., the site featuring the new air-wall construction in its coating rooms.

Here's how the system works:

▶**Air Wall Does It**—Essential feature of the construction is an adaptation of a standard steel decking, perforated with small holes and installed as one wall in each of the coating rooms. Large fans supply conditioned air through tunnels and openings in the floor slab, connecting to spaces behind the "air walls."

The dust-laden air is exhausted from the coating rooms through openings near the ceilings in walls opposite the air walls. Then it is drawn down into exhaust tunnels, passes through spray washers to remove the dust and is finally discharged to the atmosphere above the plant roof.

The volume of air circulated is so large in proportion to the cooling load that there is little rise in temperature of the air as it passes through the room. As a result, comfortable conditions can be maintained by introducing air which is virtually at room temperature.

Twenty-two fans supply air to the manufacturing rooms. Of these, four supply air to the tunnels and air walls. The system delivers 221,000 cu. ft. of conditioned air per minute, or about 11,900 tons in 24 working hours. All fans are connected to suction plenums at one end of the manufacturing building. Upon entering these plenum spaces, the air is cleaned by passing through automatic filters.

Steam coils heat the air, and cooling coils under the control of both a humidistat and thermostat reduce the temperature of the air and dehumidify it if necessary. Chemical absorption systems were considered, but exhaustive studies of relative economy threw the decision in favor of refrigeration.

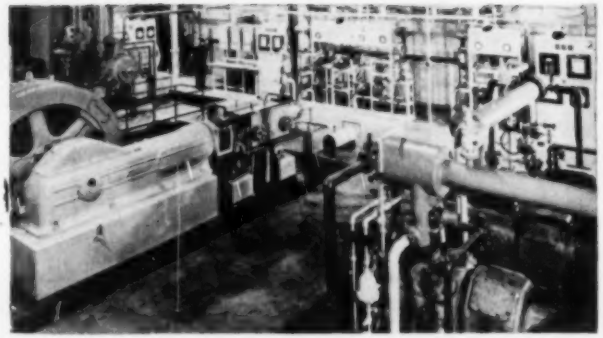
Each of the four fans supplying air to the tunnels and air walls is equipped with inlet vanes. These are controlled by a static pressure regulator in the tunnel, so that a constant pressure is maintained in each supply tunnel. Negative pressure in each of the exhaust tunnels is maintained by similar controls on each of the five exhaust fans.

▶**Flexible Operation**—A damper in the supply duct to each set of coating pans is positioned by a regulator to maintain a constant pressure in the main duct to the pan connections. All of these controls combine to make it possible for operators to vary the air supply to individual pans and to shut off the pan air entirely to particular rooms without disturbing conditions elsewhere in the systems.

Fans which supply air to the coating pans are installed in the tunnels. They receive conditioned air from one of the main coil-and-filter assemblies in the equipment room and discharge it through cooling and heating coils to main ducts. Dampered inlet pipes run from these ducts to each coating pan. A dry-bulb and dew-point temperature recorder-controller governs the supply of steam and chilled water to each set of coils. This recorder-controller is located in the coating room, where the operator can make adjustments as operations demand.

Well water supplies the cooling coils for the plenum space. All other cooling coils are fed chilled water from two refrigeration machines with centrifugal compressors driven by synchronous motors. Well water which has passed through the coils is reused in the condensers of the refrigeration machines before it is discharged.

The project, started in May 1950 was completed in January 1952. The plant is said to be one of the world's most modern for the manufacture of pharmaceuticals.



HOOKER'S NEW ANHYDROUS AMMONIA PLANT

**Anhydrous ammonia is now coming from this new $2 million plant of Hooker Electrochemical Co. at Tacoma, Wash. Built to serve the chemical industry and the pulp and paper mills of the Pacific Northwest, its entire production is contracted for and a 50 percent increase in capacity is already planned. Hooker Type S and S-3 cells convert brine to caustic, chlorine and hydrogen. Nitrogen comes from liquefaction of air. At present, output is shipped entirely in tank cars.**

## Catalin Getting New Plant For Polystyrene Production

A polystyrene plant will be built at Calumet City, Ill., for Catalin Corp. of America. Design and construction will be handled by the chemical Plants Division of Blaw-Knox Co.

The new plant will have facilities for producing monthly 1.2 million pounds of dye color powder and standard extruded pellets of polystyrene. This is the fourth contract to Blaw-Knox for Catalin's expansion in resins and plastics.



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NARROW, 8-mile vein is source of most commercial gilsonite.



LATEST use is to protect pipes from cold and corrosives.

# Gilsonite Stirs Up New Interest

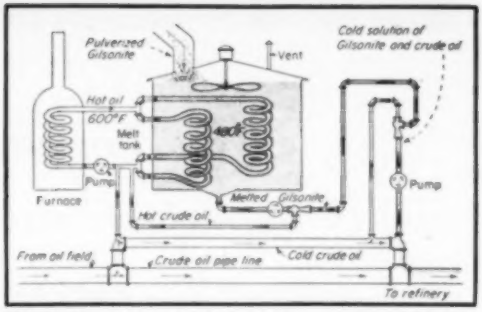
**Utah's unique deposits of gilsonite hold fresh promise for chemical process industries. Stepped-up research finds brand new uses.**

Up in the Uinta Plateau of Utah lie vast deposits of one of the world's unique commercial minerals—gilsonite. Right now, this asphalt-like hydrocarbon is pulling renewed interest from the process industries. Here's why:

- It has recently been found that gilsonite makes a permanent, simple-to-apply, corrosion-resistant insulating material for underground pipes—and at rock-bottom costs.
- Research now under way indicates that its unique physical and chemical properties may well mean new uses as a chemical raw material—such as in the resins field.
- Mixed with crude oil, gilsonite can be processed by the usual refinery methods to hike output of heavy fuel oil—a trick one refinery put to use last year.
- Other well-known uses in the process industries—chemical tank linings, corrosion-resistant varnishes, wire and cable coverings, asphalt tile—keep up a steady growth.

▶**Plenty to Draw From**—Gilsonite—apparently derived from conventional types of crude oil—occurs as a jet-black, friable, high-purity ore in narrow and vertical veins (see cut).

These veins may be up to 22 ft. wide and 1,400 ft. deep; the deepest mine has gone down only about 600 ft. The only known commercial deposits of gilsonite occur in a 60-mile belt that centers near Bonanza, Utah.




UNIQUE use is to mix with crude to up output of fuel oil.

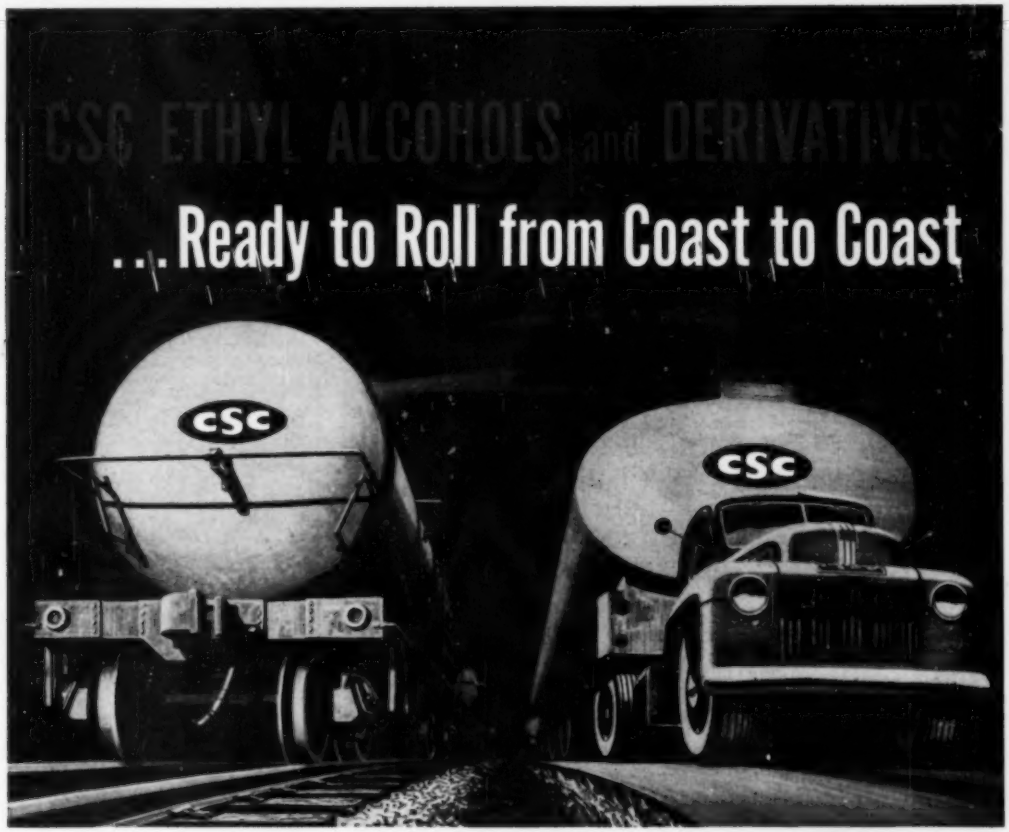
This year's output will top 80,000 tons, estimates American Gilsonite Co. of Salt Lake City, with about 45,000 tons going into process industry markets. Another 35,000 tons or so will be used in petroleum processing. American Gilsonite, owned jointly by Standard Oil of California and Barber Oil Corp., is the biggest producer by far.

But there's plenty of gilsonite yet to be tapped; at least 16 million tons is easily available for commercial development. Since a ton of gilsonite is equal to 5.6 bbl. of oil, it's estimated that the "solid oil" reserves around Bonanza are equivalent to some 90 million barrels of crude.

▶**Center of Interest**—Much of the new-found interest in gilsonite stems from American Gilsonite's recent discovery that it makes an excellent insulator* for underground pipes.

It's very easy to apply the gilsonite. Loose, sized material is simply poured around the pipe so as to surround it on all sides to a thickness of 3-5 in. It is lightly tamped

*Gilsulate, American Gilsonite's insulation grade of gilsonite, has a thermal conductivity of 0.42 Btu. per hr. per deg. F. per sq. ft. per in. of thickness.




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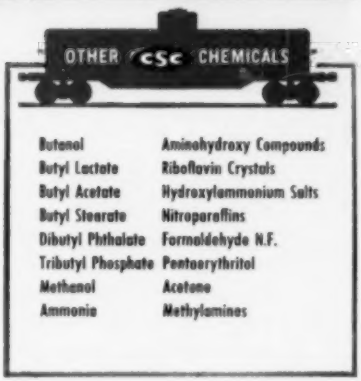
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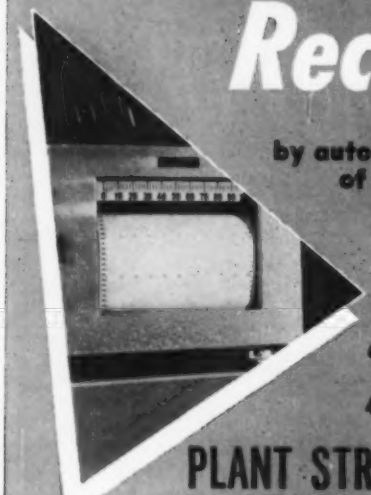
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lightly into place and the trench is refilled with earth.

Steam or hot water is then passed through the pipe for 15-30 hr. The heat fuses the gilsonite in contact with the pipe to form a plastic coating (see cut).

This coating—about 0.5-1.0 in. thick—is bonded tightly to the pipe's surface and will expand and contract without tearing. From this inner coat, the gilsonite grades outwardly into a sintered zone, that's impervious to water and gives excellent thermal insulation. Finally, a zone of unconsolidated particles provides a high load-carrying cushion.

Fused gilsonite also gives permanent protection against acid or alkaline ground water, root attacks and bacterial action. It is practically inert to all mineral acids and alkalis except nitric acid. It is also an excellent electrical insulator.

▶ **Cost Is Low**—American Gilsonite says that its material is the cheapest available for protecting and insulating underground pipes.

In the case of a mile-long steam line, the cost of labor and materials totted up to only $1.30 per linear-foot. The usual methods and materials would have hit close to $12 per ft.

In another case, a 6-in. steel line to carry 40 psig. steam and a 2-in. condensate return line were buried in a ditch 18 in. deep and 16 in. wide. The pipes were supported at 12-ft. intervals on reinforcing rods imbedded in concrete.

Labor to handle gilsonite on the job and to refill the ditch with dirt was less than 0.25 man-hr. per ft. Total cost was $2.45 per ft. The insulation was equivalent to a 4-in. application of 85 percent magnesia. Besides, the pipes were fully protected from corrosion.

Gilsonite's potential as a pipe protectant hasn't yet been fully explored. Some companies, meanwhile, are testing it for corrosion protection of pipes other than steam and hot water lines. As one person at American Gilsonite put it: "This is going to turn out to be something big—bigger than we ever suspected."

Softening point of gilsonite ranges from 280 to 350 deg. F. Work is now under way to determine how it behaves at temperatures of 500-600 deg. F. and beyond.

▶ **Mixed with Oil**—Another new use for gilsonite is to dissolve it with crude oil for processing by the usual refinery methods. Because of its high Btu. content, low sulphur and high viscosity, gilsonite increases the output of high-grade heavy fuel oil.

An injection plant at Bonanza mixes

gilsonite with crude oil (see cut) piped from the Rangely field in Colorado. The mixture then goes to the refinery of Standard's affiliate in Salt Lake City.

Gilsonite is first melted and heated to about 480 deg. F., then mixed with a small amount of hot crude oil, finally mixed with a larger volume of cold crude. The mixture is then injected back into the main pipeline.

Some 3,000 tons of gilsonite is now being melted and mixed with Rangely crude each month. Since a ton of gilsonite is equal to about 5.6 bbl. of crude oil, this is equivalent to some 205,000 bbl. of oil yearly.

▶**New Chemical Uses**—Meanwhile, gilsonite is holding on to a host of markets in the chemical process industries. One grade of cleaned, crushed and screened ore, for example, is used in making storage battery cases as well as in protective varnishes, moldings, chemical tank linings and cable coverings.

Another grade finds its biggest use in the manufacture of asphalt tiles. Pulverized gilsonite is used in the sealing materials applied as an undercoat to automobiles.

But American Gilsonite still has high hopes that gilsonite may soon find brand new uses as a chemical raw material.

Research work, largely at the University of Utah, centers around combinations of waxes or organic acids with gilsonite or gilsonite resins. This work might well open up new chemical uses, such as saturants for paper impregnation and moldable dielectrics.

One thing is now certain: gilsonite —produced commercially since 1904 —is taking on a new stature in the chemical process industries.

## Uranium and Copper Project For Kennecott in Australia

Kennecott Copper Co. plans to set up a big plant at Rum Jungle in Australia's Northern Territory to treat copper and uranium ore. A team from the U.S. Atomic Energy Commission recently inspected Rum Jungle, reputed to be Australia's largest uranium field and one of the world's biggest.

A Kennecott expert is now on the scene, sizing up the field. Kennecott is also interested in putting up a copper treatment plant in Australia and will look over other mining areas.

The Government Commonwealth Bureau of Mineral Resources wants preliminary treatment of uranium done at Rum Jungle to cut transportation costs. Kennecott would then separate the uranium ore by flotation before treating the copper.


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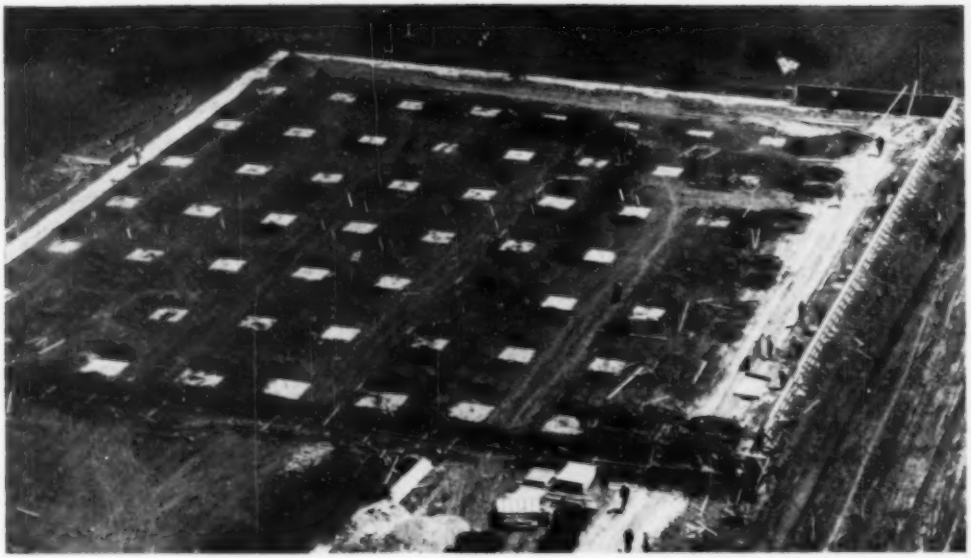
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# New Pattern Emerges for Cyanamid

**Acrylonitrile plant makes Cyanamid for first time integrated producer of hydrocarbon chemicals. Move parallels earlier diversification from calcium cyanamide.**

When American Cyanamid Co. decided to build a $50 million plant near New Orleans to make chemicals from natural gas it reached one of the most important turning points in its 45-year history. For the move puts Cyanamid, for the first time, smack into basic production of chemicals from hydrocarbon raw materials.

▶**Significant Step**–Of course, acrylonitrile for the manufacture of its new acrylic fiber X-51 was what Cyanamid was after when it decided to build the plant. But there's more to the story than that.

Starting from natural gas, Cyanamid will first produce ammonia, acetylene and hydrocyanic acid. From these, in turn, it will get ammonium sulphate and acrylonitrile.

Significantly, however, all of these chemicals are basic materials from which Cyanamid can someday turn out a diversity of both hydrocarbon and nitrogen chemicals. Thus, integrated back to natural gas, Cyanamid becomes a new basic producer of chemicals from hydrocarbons.

▶**Earlier Parallel**–When Cyanamid was founded in 1907, it was basic in the production of calcium cyanamide from calcium carbide and nitrogen. At the time, calcium cyanamide was used only as a source of nitrogen fertilizers.

Today, calcium cyanamide is the parent of hundreds of other chemicals. Among them: melamine for resins; calcium cyanide, used as a fumigant and to harden metals; ferro and ferri cyanides, used in photography and in blueprint papers; guanidines for making sulfa drugs and folic acid; and scores of agricultural products such as fertilizers, weed killers and insecticides.

Similarly, the new move into hydrocarbon and nitrogen chemicals from basic raw materials opens the way to further diversification. From anhydrous ammonia, hydrocyanic acid, acetylene and acrylonitrile, all to be made at the New Orleans plant, Cyanamid can build countless new chemicals.

▶**Exciting Vistas**–Anhydrous ammonia, for example, is one of the most versatile chemical intermediates. In addition, it's widely used as a refrigerant and in the production of nitric acid. A growing use in the South is its direct application as a fertilizer to the soils of the Mississippi delta. Ammonium sulphate, too, is an important fertilizer.

Acrylonitrile is one of the most exciting chemicals to be produced at the new plant. It's used in the manufacture of synthetic rubbers that make possible self-sealing bulletproof gasoline tanks. It's widely used in plastics.

Right now, it's opening up the new and growing field of acrylic fibers. Cyanamid will itself consume much of the acrylonitrile made at New Orleans in the manufacture of its own synthetic wool-like fiber X-51, one of the newest of the acrylics. Many others are still being developed. Acrylonitrile also goes into the new soil stabilizing compounds. In short, acrylonitrile's possibilities as a building block for new chemicals are just beginning to be put to work.

▶**Research Pays**–Cyanamid's growth from a one-product company to one of the most diversified chemical manufacturers in the nation is primarily a story of research and a willingness to commit vast sums to the uncertainties of the laboratory. These sums have added up to as much as 5 percent of total income, one of the highest percentages in all industry. In pharmaceuticals alone, this willingness to back research with money resulted last year in five new forms of aureomycin, a hog cholera vaccine, distemper vaccines for dogs and for those valuable fur-bearing political animals—mink.

▶**Structure**–All told, Cyanamid has seven operating divisions: Calco, agri-

## . . . and another

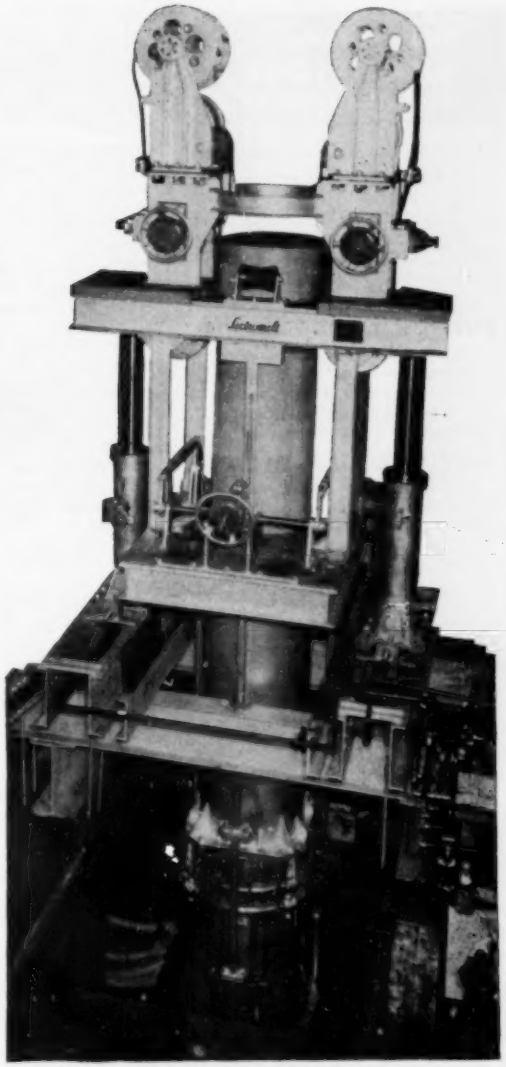
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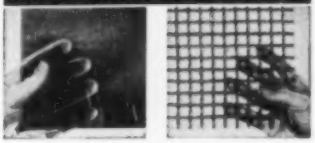
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Chemical Construction Corp., a Cyanamid subsidiary, develops new chemical manufacturing processes and constructs chemical plants all over the world. A recently organized sister corporation, Chemical Construction Inter-American Ltd., designs and builds chemical plants in Western Hemisphere countries other than the United States. Still another subsidiary, Davis & Geck, Inc., makes surgical sutures.

In addition, Arizona Chemical Co. is jointly owned by Cyanamid and International Paper Co., and Jefferson Chemical Co. is owned by Cyanamid and the Texas Co.

Today, Cyanamid has more than 20,000 employees at work turning out over 5,000 products for more than 200 industries. They work in some 42 plants across the country.

With its decision to become an integrated producer of chemicals from natural gas, American Cyanamid takes another step toward greater diversification. Such steps have marked its growth since it began 45 years ago as a producer of calcium cyanamide to its present position as the nation's fourth largest manufacturer of chemicals.



CHIEF ENGINEER D. H. W. Felch holds print of Cyanamid's New Orleans plant.

## Chemical Corps Soldiers Organize Own Societies

A professional society of college-trained soldier-scientists in the fields of statistics and quality control has recently been organized at the Army Chemical Center, Md., headquarters of the Chemical Corps.

A nucleus of 20 enlisted men, assigned to the Chemical Center in jobs within these fields, have banded together to form the society. These military specialists are classified under the Army's Scientific and Professional Personnel Program, designed to utilize technically trained enlisted personnel.

The Army Chemical Center Industrial Statistics Society is the name the men have given their organization, and the statement of their aims and purposes declares:

"The ACC Industrial Statistics Society brings together the statisticians, biometricians and quality control engineers of the Technical Detachments at the Army Chemical Center:

"To facilitate a beneficial exchange of technical, theoretical and methodological information among its members;

"To serve the Chemical Corps and the Armed Forces by encouraging and inculcating the use of modern and effective methods of statistical analysis, quality control and design of experiments;

"To associate with national societies of statisticians and quality control engineers and coordinate with their activities;

"To bring experts in these fields to the Chemical Center to improve the existing state of knowledge;

"To correspond with technical and scientific publications concerning noteworthy developments and discoveries of its members;

"To present to its members scientific papers of interest;

"To foster mutual good will and understanding between statisticians, biometricians and quality control engineers in the Armed Forces and in industry."

At their first meeting the original 20 charter members of the group discussed the nature of the society and elected officers. Pfc. Leonard Janofsky of Bayonne, N. J., was named president of the group. Other officers chosen were Pfc. David Howes of Holyoke, Mass., secretary; and Pfc.'s William Meirowitz, New York, N. Y., and David Newman, Huntley, Minn., vice presidents.

At the second meeting the members heard Pfc. Meirowitz, who presented the first in a series of talks on "Quality Control." Their third meeting featured Theorn M. Vining, a civilian statistician assigned to the Chemical Center.

The Commanding General of the Center, Brig. Gen. William M. Creasy, has taken interest in the formation of such professional groups among the enlisted specialists assigned there. The statistical society is the second professional organization at ACC, the enlisted chemical engineers having organized a society previously (see Chem. Eng., May 1952, p. 148).

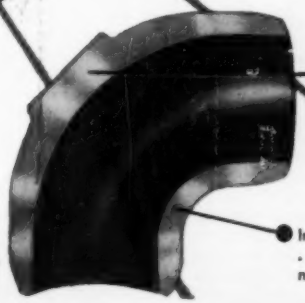
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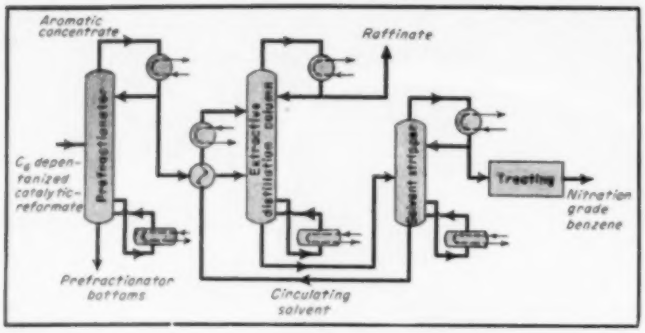


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# Boost for Petrobenzene

**Shell's extractive distillation process recovers benzene from petroleum aromatics. Off to a fast start, it goes on stream in three new plants this summer.**

Early in 1947, Shell Oil turned out the first commercial benzene made from petroleum. Using an extractive distillation system, its engineers converted wartime toluene facilities at the company's Wilmington, Calif., refinery. To do so required no mechanical change.

Since then similar conversions were made at the Ponca City, Okla., refinery of Continental Oil Co.; the Texas City plant of Pan American Refining Co; and the plant of Standard Oil Co. (Indiana) at Whiting.

This year, probably before the end of the summer, three more oil companies will be making benzene. They are . . .

- Atlas Processing Co., Shreveport, La. Plant cost: $3.4 million. Capacity: 6 million gallons per year.
- Standard Oil Co. (California), El Segundo. Cost: $12 million. Capacity: 13 million gallons per year.
- Shell Oil Co., Houston. Cost: $12 million. Capacity: 18 million gallons per year.

All three plants, the first of their kind built specifically for benzene production, will recover benzene with the extractive distillation process.

Shell engineers, who developed the process in 1940, caught the benzene worm early. Other recovery processes competing in the current expansion program came later. Udex—a liquid-liquid extraction using diethylene glycol-water solvent—will soon be tested at the Cosden Petroleum Corp. refinery at Big Spring, Tex. Arosorb—silica-gel adsorption—will be installed at the Sun Oil refinery in Marcus Hook, Pa.; as yet it is untried. But by the end of the year, the Shell process will be recovering benzene at the rate of 68 million gallons per year.

▶ **Why Petrobenzene?**—Today we cannot make enough benzene, according to the National Production Authority. Defense assignments, particularly for phenol and styrene, have been heavy. Since 1949, total U. S. production has jumped considerably; yet we will be 30 million gallons short in 1952, says NPA.

Coal tar producers, conventional makers of benzene, cannot keep the pace. Last year, they made about 180 million gallons of benzene—100 million shy of U. S. needs.

The U. S. has to depend on foreign aid. We imported 60 million gallons of benzene last year. However, this year with petrobenzene production rising, only about 35 million are due in.

Trying to close the gap, the U. S. decided on petroleum as a source of benzene. Only 25 million gallons of petrobenzene were made last year. But by the end of 1953, output should reach 150 million.

In the long run, benzene may be hard to get, but last month producers found the benzene cupboard well stashed. "In fact, it's coming out our ears," one said, and no one knows why. But, petrobenzene makers have no real worry. Most have contracts to sell whatever benzene they make.

▶ **How Shell Process Works**—Extractive distillation* is a three step process: (1) pre-fractionation of the petroleum stock in one or two columns to prepare a concentrate fraction of a single aromatic (benzene, toluene or xylenes); (2) distillation of the fraction mixed with a high-boiling solvent such as phenol, followed by stripping of the aromatic from the solvent; (3) a mild treating, usually required only to pass acid-wash color test, which is a difficult trial.

1. Depentanized naphtha from a Platforming unit or straight run gasoline high in benzene enters the pre-fractionation column (usually 65 trays). It takes down with it those constituents that cannot be separated from benzene in the following extractive distillation step.

2. Aromatic concentrate passing from the top of the pre-fractionator charges the extraction column (60 to 70 trays) at mid-point. Hydrocarbon-free solvent (phenol) enters several plates above. Upper section above this port knocks back the solvent; hence, top product is essentially aromatic-free and solvent-free raffinate.

Lower section of the column gathers up the aromatic and solvent. A stripping column (30 trays) then separates the two.

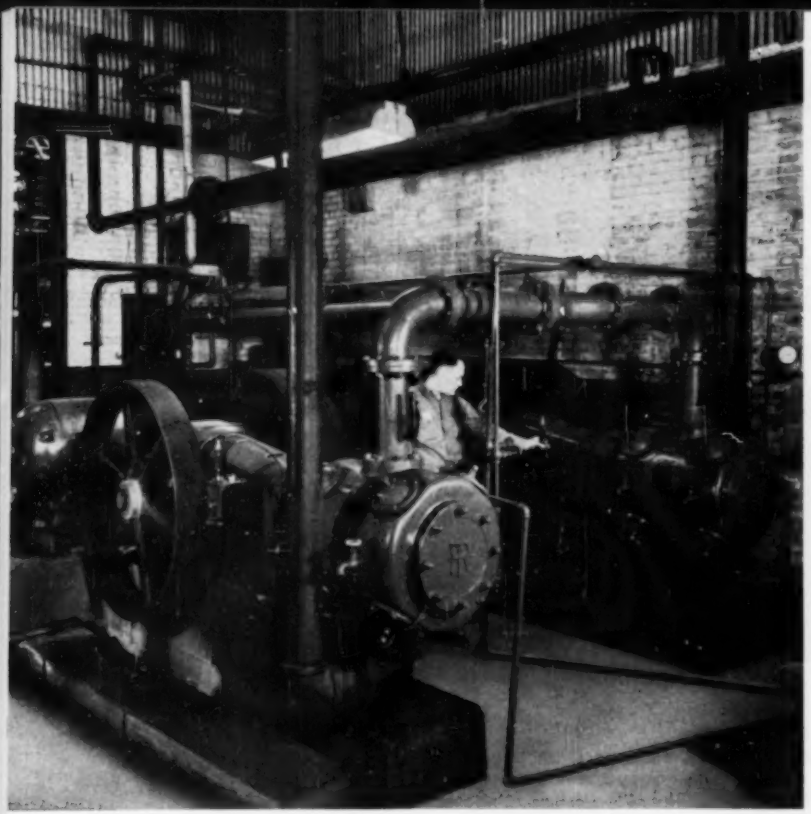
3. A small solvent cleanup still (single stage) continuously rejects small amounts of high-boiling reaction products of phenol and diolefins, and phenol and iron. Otherwise, these products would pile up in the circulating solvent.

Oxygen is excluded from the system by gas-blanketing accumulators and run-down tanks that handle streams running to the extraction system. Phenol reaction products, as a result, are less than 1 bbl. per week in a plant that recovers 1,000 bbl. per day of benzene.

Corrosion raises no major obstacles. Corrosion of carbon steel by phenol at temperatures below 170 deg. C. is negligible. All equipment in moderately cold phenol service—including lines, columns, trays and bubble caps—can be of carbon steel. Valve trim, reboiler tubes and tube sheets in the extraction and stripping columns are normally fabricated of Type 316 stainless steel. The two hot solvent pumps are made of special Fe-Cr-Ni alloy.

Chemical requirements, per barrel of benzene, are: 0.2 lb. of phenol, 3 lb. of 98-percent sulphuric acid, less than 1 lb. of caustic. Utilities: 1.1 million Btu. of fuel, 3,100 gal. of circulating cooling water (90-120 deg. F.), 3.3 kwh. electric power. Labor: 14 c. for operating labor (direct cost), 10 c. for maintenance labor and materials.

* C. L. Dunn and G. B. Liedholm, "Shell Extractive Distillation Process for Recovery Of High-Purity Aromatics," before American Petroleum Institute's Division of Refining, San Francisco, Calif., May 14, 1952.



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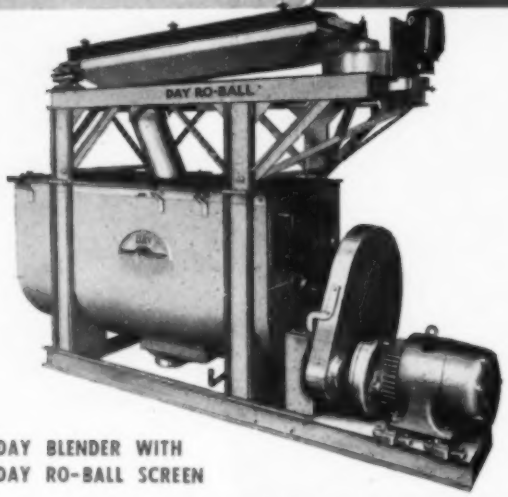
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## Greater Glutamate Capacity For International Minerals

Its amino products plant at San Jose, Calif., is being expanded by International Minerals & Chemical Corp. Two-thirds more capacity will be installed for manufacture of monosodium glutamate.

Two new tanks of 8,000 tons each, together with auxiliary facilities, will be used for storage of concentrated Steffens filtrate. This will give the San Jose plant a total of 11 such tanks. Other improvements: a third boiler, two new cooling towers and two new reagent storage tanks.

New construction now in progress will represent an investment of about $1.5 million at San Jose.

Additional construction work soon will be undertaken by International's Amino Products Division. It calls for an outlay of about $1.8 million for five new concentrators at the sources of the corporation's supply of Steffens filtrate. This equipment will be installed at sugar beet plants in Idaho and Utah, as well as at other plants not yet identified.

The current expansion will lift capacity of the San Jose plant from 4 million to 6.6 million pounds of monosodium glutamate a year. And the new concentrators at International's sources should help to keep the San Jose plant running close to peak.

## National Lead Gets Processes For Cuban Nickel Production

National Lead Co. has acquired a majority interest in Nickel Processing Corp., operator of the government-owned nickel plant at Nicaro, Cuba. National Lead and Fomento Minerales de Cuba have purchased N. V. Billiton Maatschappij's interest in Nickel Processing Corp. and rights to certain processes that may further expand the output of the plant.

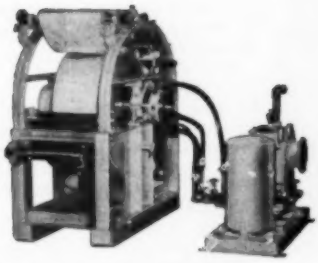
Production of nickel at Nicaro was resumed last February. After World War II the unit was closed down, but it had to be reactivated to provide vital nickel for defense industries. Full production at a rate of about 30 million pounds of nickel per year is slated to begin this month.

Nickel Processing Corp. is currently pilot-planting a process for increasing capacity of the present facilities and also for recovering cobalt from the ores treated at Nicaro. Cobalt is needed for defense and National Lead is building a unit at Fredericktown, Mo., that will also further increase production of this metal.



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HOUDRY: He shows his oxidizing catalytic unit made of coated porcelain rods.

# Catalyst Burns Organic Vapors

**The Houdry oxidizing catalytic unit finds its first uses in the chemical process industries to destroy fumes from enamel-baking operations and petroleum refining.**

The first industrial installation of the Houdry catalytic oxidizing unit has just been made; it's said to be completely successful in destroying fumes from the baking ovens of the Enamelstrip Corp., Allentown, Pa.

Batteries of the catalytic units (see cut) have been installed in each of the stacks venting fumes from Enamelstrip's four enamel baking ovens. Pennsylvania's Department of Health reports the units as 93-100 percent efficient.

Thus Enamelstrip has eliminated a troublesome pollution and odor problem. In addition, the company's executives report recovery of enough heat from the units to operate the enamel ovens.

Sun Oil Co. is putting in the second industrial installation of the Houdry units at its Marcus Hook, Pa., refinery. The Sun units will start operations soon to consume wasted petroleum gases and vapors.

Houdry catalytic units are also going into other chemical processing plants. They promise, according to Houdry himself, to become an important development in the prevention of atmospheric pollution from certain types of organic vapors.

▶ **Developed by Houdry**—The new catalytic unit was developed by Eugene J. Houdry, founder of Houdry Process Co. and well-known for his catalytic petroleum treating processes. He resigned as president of Houdry Process Co. in 1948.

The Houdry unit is actually three years old, having been put on the market in 1949. Previously to the Enamelstrip installation, however, its prime use was on materials handling trucks in industrial plants. Here it converts carbon monoxide exhausts to carbon dioxide.

About 1,000 installations have already been made on industrial trucks; each contains from 2-12 catalytic units, depending on the size of the engine. It has been used only on engines burning unleaded gasoline; metal vapors from leaded gasoline poison the catalyst.

The Houdry unit is now being manufactured by Oxy-Catalyst Manufacturing Co., Inc., of Wayne, Pa., near Philadelphia. Eugene J. Houdry is president; his two sons are vice presidents.

▶ **Made of Porcelain Rods**—Houdry's unit is made up of two thick porcelain end plates, a spacer bar of porcelain and 73 coated porcelain rods.

End plates are joined rigidly at their centers by the spacer bar after the rods have been inserted into shallow sockets in the plates. There is some play in the rods to allow for expansion and contraction during temperature changes.

Rods are assembled in staggered rows and are tear-shaped in cross-section to insure good contact with the gases, to eliminate turbulence and to cut down resistance to fumes passing through the catalytic zone.

Vital part of the unit is the catalyst coating—only 0.003 in. thick—on the rods. This is a film of catalytic alumina and platinum alloy applied by a special process in such a way that it remains adherent, intact and resistant to high temperatures and thermal shocks.

Each catalytic unit is 5.5 in. long, some 3 in. wide and 3½ in. high.

Each installation is tailored to meet the particular needs. In each instance, the units are set in layers, like building blocks, in the venting stack.

The catalyst is said to be 90 percent effective after 5,000 hours of steady use.

▶ **Many Uses Seen**—Houdry says the catalyst, which burns fuel with high efficiency, can be applied wherever heat is generated from fuel. He sees widespread use of the units, particularly for destroying noxious and harmful industrial odors.

He says that installations are now being put in, engineered or are in the




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planning stage for half a dozen other companies. Included in the chemical processing applications are a large printing firm, a dyeing company and an oil refiner.

For the enamel and synthetic finishing industries, B. L. Gamble, chief engineer of Ferro-Enamel Corp. of Cleveland, had this to say: "When I consider the possibilities of applying the catalyst to the synthetic finishing industry . . . I can visualize an entirely new concept of paint baking."

▶ **Enamelstrip's Setup** – Enamelstrip Corp.–first industrial plant to use the Houdry units–produces enamel paint coatings on metal strip in a continuous operation. The coatings are applied by dipping a loop of a continuously moving metal strip in a bath of enamel paint thinned with solvent, principally commercial xylene.

Wet strip is then air-dried with forced hot air in enclosed chambers. Exhaust from this drying process is then passed through the catalytic reaction chambers where the solvent vapors are oxidized to carbon dioxide and water.

Batteries of the units have been installed in each of the stacks from Enamelstrip's four baking ovens. The four batteries have a total of 918 units. The installation was completed late this March.

"There are absolutely no odors," says Arthur E. Uhleen, executive vice president and general manager of Enamelstrip. Stack tests made by Pennsylvania's Bureau of Industrial Hygiene bear this out: "Tests . . . indicate that these reaction chambers are from 93 to 100 percent efficient" in oxidizing the hydrocarbon solvent vapors to carbon dioxide.

Enamelstrip's ovens were formerly heated by gas exclusively. But now, Uhleen says, heat recovered through the catalysts now allows the plant to save 90 percent of its gas costs of about $3,000 a month.

The installation, put in by Enamelstrip employees, cost $16,000. Of this, about $13,000 was for the Houdry catalytic units. Uhleen expects the installation to pay for itself in six months.

In addition, Uhleen says that the Enamelstrip plant has been able to increase its output more than 40 percent because of the heat now available from the catalyst units.

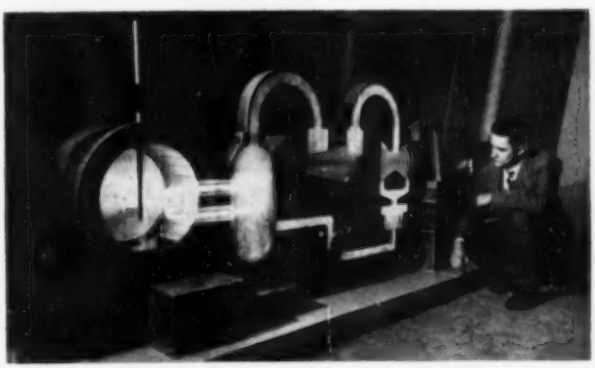
## Dow to Make Polyvinyl Chloride at Midland

Construction is moving right along, reports Dr. R. H. Boundy, manager of the plastics department, on the new polyvinyl chloride plant of Dow Chemical Co. at Midland, Mich. The new facilities, including polymerization and drying units, are expected to be operating early this summer.

Although Dow for years has been producing a copolymer of vinyl chloride and vinylidene chloride, this marks Dow's entry into manufacture of polyvinyl chloride for the plastics industry.

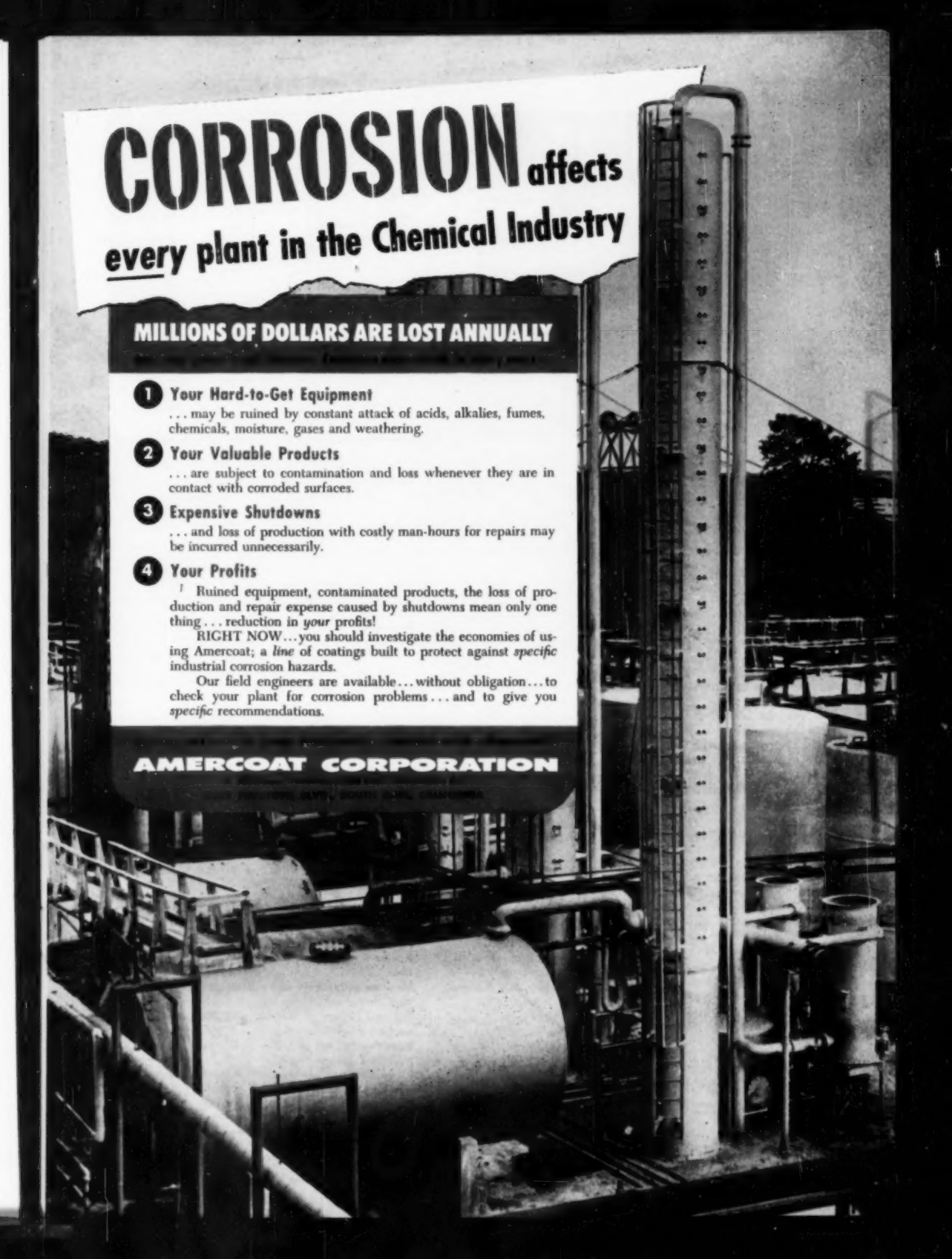
Dow will supply polyvinyl chloride as unformulated resin, but won't get into calendering, extrusion or injection molding.

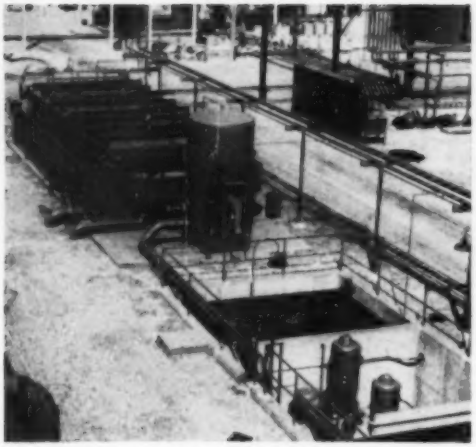
A widely used thermoplastic, polyvinyl chloride can be employed to make rigid or flexible products.

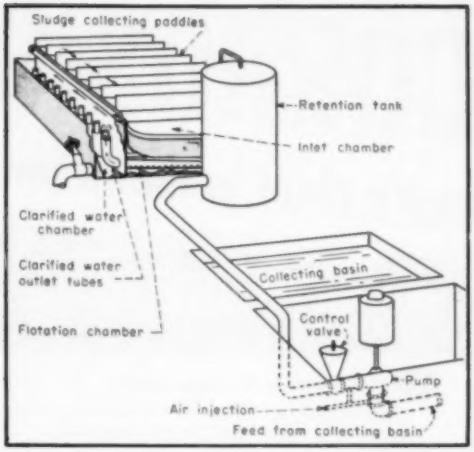


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# Dissolved Air Goes to Work

**Dissolved-air process for floating suspended solids in waste has fast become an inter-industry favorite. Chemical plants may soon get in the act.**

Success in one industry led to the adoption of the dissolved-air process in several industries. Invented by Norwegians, Karl Sveen and Nils Pedersen, dissolved air was first used in paper mills to float solids in white water waste.

Now, an advanced process, developed by Bulkley, Dunton Processes, Inc., New York, and named Colloidair, is cleaning up waste waters from oil refineries, oil fields, soap plants, meat packing units, fish canneries, railroad-car wash units and general machining operations.

Chemical industry will probably pick it up next. Big attraction: Besides removing suspended materials, the process can be adapted to take away such colloidal materials as oil and carbon. Recently, one well-known chemical company installed the process in a large Southwestern plant.*

► **Pressure Does It**—In dissolved-air flotation, pressure makes the difference. Other processes have used air to float waste. However, these pass diffused air through waste water under atmospheric pressure (*Chem. Eng.*, April 1951, p. 107).

In the Colloidair system, air dissolves in water kept under pressure—about 25 psi. When the pressure is let up, bubbles ride to the surface like they do when a bottle of pop is opened, carrying suspended waste with them.

Of course, dissolved air can't remove colloids. But by adding colloidal floc-forming chemicals, the process can take out both emulsified and free oil as well as suspended solids, and frequently many of the dissolved organic materials.

Laboratory tests run prior to installation determine the types and combinations of the floc chemicals. Alum and ferric salts have been used many times. Activated sodium silicate is one of the common floc-formers used with these two.

Generally, engineers report high efficiency. Speaking recently before the American Petroleum Institute, Consulting Engineer Nicholas D'Arcy, Jr., said, "Treatment of waste water by dissolved-air flotation, and particularly the combination of colloidal flocs

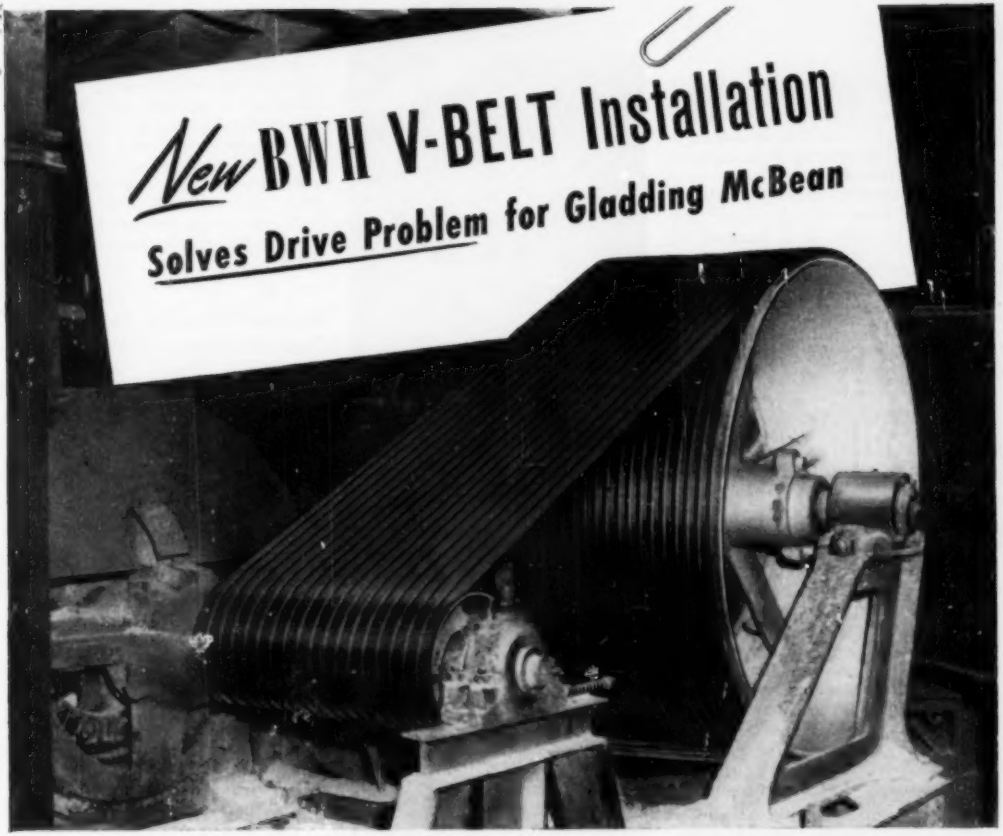
* This chemical process is under wraps. Neither Bulkley, Dunton nor the chemical company cares to give details at this time.

## Dissolved-Air Process On the Job . . .

| At the Plant of | What It Does | Capacity, Gal. per Day | Started Operating |
|---|---|---|---|
| Lever Bros. Los Angeles | Removes fats and oils, cleans up condenser circuit recirculation. | 5,500,000 | Jan. '51 |
| Lever Bros. Hammond, Ind. | Removes fats and oils for pollution-free discharge. | 4,000,000 | Jan. '52 |
| Associated Oil Co. Baldwin Hills, Calif. | Removes crude oil from brine. | 350,000 | Jan. '50 |
| Standard Oil of California Torrance, Calif. | Cleans production water for injection. | 40,000 | Sept. '49 |
| N. Y. & Pennsylvania Co. Johnsonburg, Pa. | Recovers pulp fibers and filter. | 1,200,000 | April '52 |
| St. Helens Pulp & Paper Co. St. Helens, Ore. | Recovers pulp fibers and filter. | 2,800,000 | Sept. '52 |
| Chrysler Corp. Trenton, Mich. | Removes residual oil from machining operations. | 500,000 | March '52 |
| Aerojet Corp. Azusa, Calif. | Removes oxidizers and nitric from process water. | 30,000 | Feb. '52 |
| E. J. Kahn. Cincinnati, Ohio | Reclaims fats, oils and greases from waste water. | 500,000 | June '51 |
| Tobin Packing Co. Estherville, Iowa | Reclaims fats, oils and greases from waste water. | 500,000 | Nov. '51 |

# *New* BWH V-BELT Installation

## Solves Drive Problem for Gladding McBean



Drive at pug mill of Gladding McBean & Co. Safety guard removed for photographic purposes

**The Problem:**

The drive at the pug mill at the Gladding McBean & Company brick plant, Pittsburg, California, is so vital to their production it cannot be out of service for any length of time. It must operate under dusty conditions which induce slippage in ordinary belts. It must be able to take very severe pulsating loads.

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Warehouse Stock: 111 N. Canal St., Chicago, Illinois **Distributors in all Principal Cities**

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and dissolved air . . . produces an effluent of greater clarity than can be obtained with any other known economical method of treating large volumes of industrial waste water."

Nevertheless, the process is no cure-all for all waste water problems, says D'Arcy. Basically, it is designed to assist gravity separators—not to supplant them.

For refinery work he recommends that "a primary gravimetric separator be used for the initial separation of free-breaking oil, and that the gravimetric separator be used to serve as a surge tank ahead of the dissolved-air flotation unit."

Right now, prospects for Colloidair look good. Besides present uses, Bulkley Dunton sees possible application in recovering aluminum hydroxide and titanium pigments.

▶ **How It Works**—All waste flows from the plant to the collecting basins. From here a pump sends it through the flow control valve to the dwell tank. Here the waste water is under pressure of about 25 psi.

Meanwhile, air is injected into the pump suction. At the same point, floc-forming chemicals may be added to the waste.

From the tank, the water automatically flows through the pressure control valve into the inlet chamber of the separator. In the inlet compartment, the water is stilled. It then overflows a submerged weir and passes into the flotation chamber.

At this time, air in solution is coming up to the surface as microscopic-size bubbles.

From the time the flow enters the inlet chamber all operation is visible—the flocculation, degasification, particle separation, grease collection, and the clarified water overflow.

Grease and solids floated to the surface are continuously pushed by flight scrapers towards the recovery trough at the far end of the separator. The adjusted scrapers do not dip into the body of the liquid; thus the liquid is not disturbed. Sludge is collected in the recovery chamber and periodically removed.

Clarified effluent is continuously removed from the bottom of the flotation chamber through uniformly spaced recovery tubes with adjustable height risers. Effluent discharges into the collection trough for reuse or disposal.

Colloidair units capable of treating 1,000 gpm. of water would cost about $25,000. Cost of chemicals range from $1 to $10 per $1,000 bbl. of effluent treated.



## Solvay's New Soda Ash Plant At Syracuse Ready to Operate

Its new soda ash plant at Syracuse, N. Y., has just been completed by the Solvay Process Division of Allied Chemical & Dye Corp. The new unit, embodying the most advanced technology in alkali manufacture, is a key project in Solvay's postwar expansion that has involved a total capital outlay in excess of $20 million.

The towering 220-ft. center structure of the new multi-million dollar plant houses the distillation columns that are the heart of the ammonia-soda process for making soda ash. Elevators traveling 200 ft. per min. enable workers to reach any part of the distilling columns quickly.

Lower levels are occupied by equipment used in other steps of the process. Included in this equipment are compressors and dryers.

A 30-ton capacity traveling crane makes it possible to move or repair heavy compressor machinery with minimum delay.

The entire process is inclosed from the time raw material gases and liquids enter the plant until the white crystalline soda comes off rotating filters. It takes 50,000 ft. of piping to make this possible.

Chemical processing equipment designs and manufacturing specifications of the new plant were prepared by the Solvay Engineering Department, under the direction of D. O. Yeoman, director of development, and C. P. Hackett, who was chief engineer during most of the construction and is now assistant director of development.

The new unit employs modern centralized controls and process recording equipment that makes the plant easier to operate and control than any previous unit of its kind.

Each day, the new plant will produce enough soda ash for the manufacture of 10 million quart glass milk bottles if it all were put to that use. But of course, while the glass industry will get a big part of the soda ash output, Solvay also supplies about 40 other industries with alkali products. Soda ash is a prime raw material for other alkali products manufactured at the Syracuse plant.

## Defense Planners to Survey Nation's Research Potential

More than 5,000 industrial concerns engaged in research and development will be surveyed by the Research and Development Board of the Department of Defense to determine industry's total research and development capacity and the past and potential effect of military call-ups on this capacity.

Results will be used in locating possible contractors for the defense agencies. The survey findings will also be useful to industry. For the first time, according to the government, it will be possible to determine, for each industry and for companies of various sizes, the average expenditure per research engineer and the average percentage of sales that are spent to carry out research.

This information will be used in estimating the manpower needed to carry out budgeted research programs and the amount of research, in terms of dollars, that can be performed by staffs of a given size.

During 1952, the federal government will spend more than $1.6 billion for scientific research and development. About three-fourths of this will be for defense work, most of it to be done by the nation's industrial organizations.

## New Method Gets $CO_2$ Out of Synthesis Gas by Absorption

A new and cheaper way to rid synthesis gas of carbon dioxide has been developed by two Bureau of Mines engineers.

Synthesis gas is a mixture of carbon monoxide and hydrogen; it's obtained through the reaction of oxygen and steam with coal. Removing carbon dioxide from the gas is a necessary step in the production of synthetic liquid fuels from coal by the gas-synthesis process. This is one way of producing oil from coal and oil shale. The Bureau is studying this process as part of its continuing synthetic liquid fuels research.

*(Continued)*

Developed by Joseph H. Field and Homer E. Benson, chemical engineers in the Synthetic Liquid Fuels Research Branch of the Bureau of Mines at Bruceton, Pa., the new method employs a hot concentrated solution of potassium carbonate to absorb the carbon dioxide. Absorption occurs at pressures of 300 to 600 psi., which are used in the gas-synthesis process.

The carbonate solution is regenerated by pressure letdown and steam stripping at substantially the same temperature used in the absorption step. This eliminates the need for the heat exchange treatment used in the conventional method, and reduces the amount of steam consumed in the process.

As synthesis gas is the major cost item in producing synthetic liquid fuels from coal by the gas-synthesis process, any reduction in the cost of purifying the gas is an advance toward commercial production of oil from coal on a commercial scale.

It's expected that the new process will also be used in other processes, notably the production of ammonia from either coal or natural gas. Because large volumes of carbon dioxide must be eliminated in synthetic ammonia production, Bureau engineers feel the improved process should be valuable to this rapidly expanding industry.

## CONVENTION CALENDAR

**Manufacturing Chemists Association**, joint meeting with SOCMA, Greenbrier Hotel, White Sulphur Springs, W. Va., June 23-25.

**Synthetic Organic Chemical Manufacturers Association**, joint meeting with MCA, Greenbrier Hotel, White Sulphur Springs, W. Va., June 23-25.

**Fourth Western Packaging and Materials Handling Exposition**, Los Angeles Shrine Convention Halls, Los Angeles, August 12-14.

**Second Gordon Research Conference on Coal**, New Hampton School, New Hampton, N. H., August 25-29.

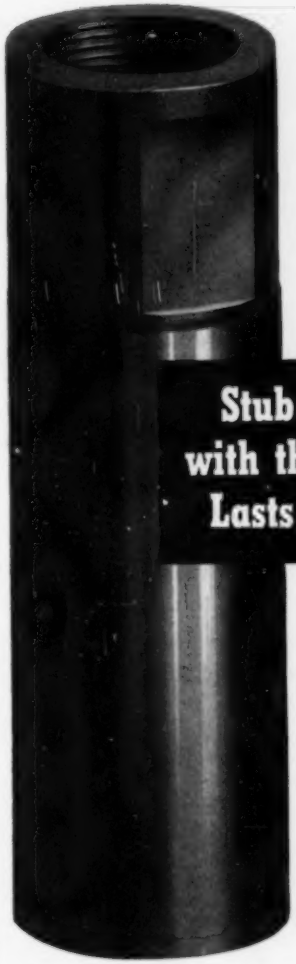
**National Conference on Industrial Hydraulics**, eighth annual conference, Sherman Hotel, Chicago, September 4.

**National Chemical Exposition**, Coliseum, Chicago, September 9-13.

**American Institute of Chemical Engineers**, Palmer House, Chicago, September 11-13.

**American Chemical Society**, national meeting, Atlantic City, September 14-19.

**Drug, Chemical & Allied Trades Section**, New York Board of Trade, annual meeting, Pocono Mannor Inn, Pocono Manor, Pa., September 25-28.

*A Colmonoy Sprayweld Process application*

**Stub shaft hard-faced with the SPRAYWELDER* Lasts 17 Times Longer**

Maintenance men working on agitators (used in the fermentation processing of an important drug) were highly pleased with this solution to their fast wearing stub shafts.

Problem: These 18 inch, 20 pound stub shafts are made of a high nickel corrosion-resistant alloy. The wear encountered is primarily abrasion, but as these shafts are used in mixing material containing both sulphuric and phosphoric acids, corrosion is also present. They had the disappointing service life of only three weeks.

Solution: Worn stub shafts are now overlaid with powdered COLMONOY No. 6 hard-facing alloy, using the COLMONOY Spraywelder*. Only 1 lb. of alloy is required to weld a wear-resistant hard-facing .020" thick, on each shaft. These reclaimed stub shafts last over a full year —over seventeen times as long as did new shafts.

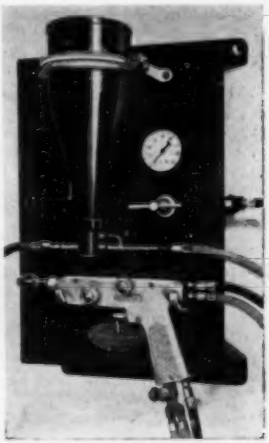
While this long uninterrupted service is the prime advantage of their using COLMONOY, the greatly lowered replacement cost is also impressive.

Remember that COLMONOY stands for a complete line of hard-facing alloys. Various alloys designed to meet every type of wear are available in many forms: rod, paste, powder, wire, and castings.

*THE SPRAYWELDER is a metal spraying unit made for applying Colmonoy powdered alloys. A smooth uniform overlay is attained by spraying. This overlay is then fused to the base metal with an oxy-acetylene flame. Only a minimum of grinding is required because of the close control (within .010") of the overlay thickness during spraying. The Spraywelder consists of the pistol, hoses, hopper, and air filter and regulator, all on a sturdy panel.

Write for more information about Colmonoy alloys and the Spraywelder.

*Branches: Long Island City, Buffalo, Chicago, Houston, Los Angeles, Montreal.*

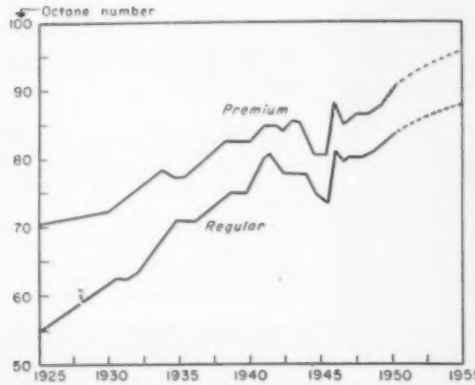


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After wartime drop, octane numbers of motor gas start rising.



Ethyl's new Houston plant will make 80 million pounds a year.

**As octanes go up . . .** **. . . U.S. gets more TEL**

# Big Jump for TEL

**Trend to higher octanes vaults tetraethyl lead into the king-size class of organic chemicals. Latest expansions have raised nation's capacity 32 percent.**

Early this spring, after a year of controls, PAD lifted its allocation on TEL. Later, Ethyl completed its big new TEL plant on the Houston Ship Channel (capacity: 80 million pounds a year). Right now, Du Pont, the only other U. S. producer of TEL is putting the finishing polish on its new Deepwater, N. J., facilities (capacity: 50 million pounds minimum). Upshot: Nation has raised its TEL capacity some 32 percent.[1]

A big booming industry, the TEL mushroom started to climb long before the present defense build-up. Between 1940 and 1950, TEL production more than doubled. Still climbing, the U. S. made about 360 million pounds last year; this year, production should reach 390; next year, 430 million.[2]

In recent years TEL has become a titan in the organic field. Last year, for instance, U. S. made more TEL than either phenol or naphthalene.

Capital costs are high. In the last six years, Ethyl has invested about $100 million in expanding capacity at Baton Rouge, building the new plant at Houston, and adding new storage terminals for TEL on the east and west coast.

Now big rivals, Ethyl and Du Pont were one-time chemical cousins. Until 1945, Du Pont operated facilities at Ethyl's Baton Rouge plant using Ethyl's basic process patents. Today, however, Ethyl makes and sells the TEL produced at Baton Rouge and Houston while Du Pont makes and sells the output of its Deepwater facilities.

► **Why the Surge?**—Besides more gasoline, trends today point to higher octanes. Recent advances in automotive design require increased octanes. In 1950, for instance, the average premium gasoline could fire only 75 percent of high-requirement cars. The average regular grade was fit for only 55 percent of all cars. Petroleum men feel octane needs will continue to increase for some time (see cut).

Higher octanes will mean more TEL. The tremendous swing to catalytic cracking has hopped octane numbers 8.5 points in 10 years, but still not enough to economically meet present or future automotive requirements. To do so, TEL contents will have to be raised. Petroleum men predict an average tetraethyl lead content of 2.5 ml. per gal. by 1955.

Ethyl is prepared. Its new Houston plant occupies 80 acres on the Ship Channel. Lying by are 320 more acres, which Ethyl will use when it expands.

► **How TEL Is Made**—Like the Baton Rouge installation, the Houston plant will provide its own chemical intermediates. These include sodium, chlorine, hydrogen chloride, ethyl chloride, ethylene dichloride and lead-sodium alloy.

The plant is divided into three operating areas: the sodium, the ethyl chloride and the tetraethyl lead area.

1. Salt is electrolytically decomposed in the sodium building, the largest structure in the plant. Here, incoming brine is evaporated, filtered and dried before being decomposed.

2. Hydrogen is burned with chlorine obtained from the sodium operations. The hydrogen chloride formed is compressed and sent to the ethyl chloride unit. Here, it reacts with ethylene to form ethyl chloride. Also in this area: manufacture of ethylene dichloride, which is used as a scavenger in anti-knock compound.

3. Incoming metallic lead is melted and combined with molten sodium to form an alloy. The alloy then reacts with the ethyl chloride to form the tetraethyl lead. At Houston, Ethyl has combined the TEL and lead-sodium operations under one roof.

After the basic reaction, the tetraethyl lead is washed, purified and then blended with other ingredients to make the finished anti-knock compound. Today, anti-knock fluid for motor gasoline contains 61 percent TEL, 18 percent ethylene dibromide, 19 percent ethylene dichloride and 2 percent dye. Aviation fluid contains no dichloride but the same TEL content.

[1] Total capacity will be an estimated 540 million pounds a year: Ethyl—380; Du Pont—160. But it is likely that Du Pont's new capacity will only replace current output.

[2] These figures are based primarily on current requirements. However, note that 128,407 short tons of lead went to TEL makers last year, according to the Bureau of Mines. Therefore, theoretical production in 1951 is 400 million pounds.



The Protection of

Century

Type TEFC* Motors

Keeps Production Rolling

T E F C

Your Maintenance Man..

who must keep your Production Turning, knows how to evaluate the inside of the Motor. Ask him about these Century Construction features.



- Vital parts of motor protected — sealed-in inner frame.
- Reverse direction of motor without changing fan — Fan runs in either direction.



- Uniform ventilation — surrounding outside of inner frame.
- Smooth straight-through ventilating passages.
- Winding electrically insulated 6 different ways.



- Uniform rotor winding — high pressure cast aluminum.
- Ball bearing housing keeps grease "in"—dirt "out"—lubricated for several years' normal service, with grease plugs when you want to lubricate bearings.



- Easy to remove fan guard for inspection—2 screws hold steel fan guard in place.

Century type TEFC protected type motors are very popular in the dust-oil and food processing industries for resisting rust and corrosive fumes. They are widely used in the metal working industries to protect the vital parts against abrasive dust or grimy oil fog.

Specify Century motors on the machines equipment you purchase, or call a Century branch office or a Century distributor when you purchase motors. Century manufactures a complete line from ½ to 400 H. P.

Century MOTORS

CENTURY ELECTRIC COMPANY

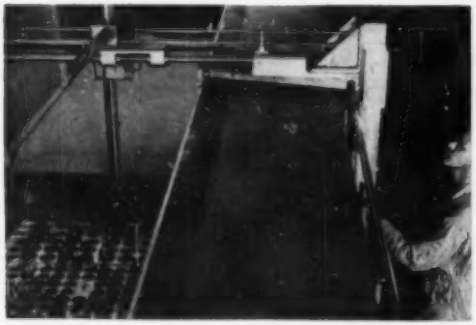
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Offices and Stock Points in Principal Cities

## When You Buy Hot Isotopes From Oak Ridge . . .



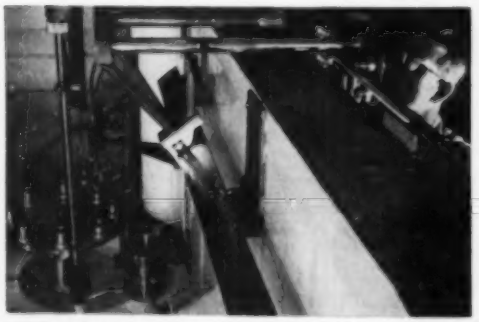
**STORAGE** of all the different kinds of radioisotopes that Oak Ridge has for sale is behind 2 ft. of concrete. The right bottle is located by a number-letter system (printed backwards so that numbers and letters are right-side-up in the mirror that let's the "salesman" see what he's doing without getting burned). Remotely-operated tongs handle the bottles.



**PICKUP** of the right bottle is the first of the steps that are necessary to get the right amount of the right product into a rayproof container that can be safely shipped to you.



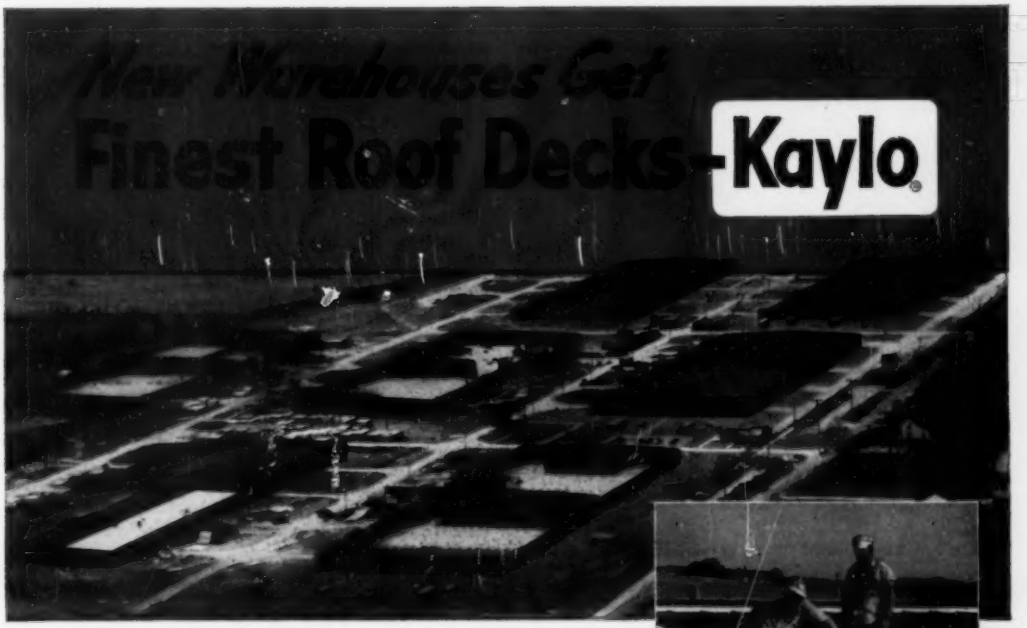
**TRANSFER** of the storage bottle by Operator George Winn. He is rolling the tongs and their load along a track to the spot where he will pipette the hot liquid into another container.



**PACKAGING** is complex when it involves bottle decapping, filling, sealing—all remotely controlled. This little shipping bottle will be measured for radiation level before it goes out.

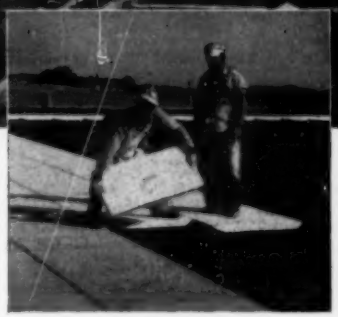


**DELIVERY** of the package. The hot commodity was put into a shipping container. Operator R. Blevins opens the hydraulically operated door and out rolls a bundle for the customer.




Joseph E. Seagram & Sons, Inc., Milan, Indiana

General Contractor: F. W. Owens Co., Louisville, Kentucky



## Kaylo Roof Tile is lightweight yet strong ... and it also insulates

The qualities essential to finest roof deck construction are combined in Kaylo Insulating Roof Tile, a remarkable, lightweight material—hydrous calcium silicate, *not glass*.

High insulating value of Kaylo Tile aids in temperature control to save on heating and cooling costs. Added fire-safety, too, is provided because the tile is incombustible.

Although Kaylo Tile have more than adequate strength for typical roof loads, a Kaylo deck weighs only six pounds per square foot. Therefore, a relatively lighter structure supports the Kaylo deck with resulting savings of structural steel.

A Kaylo deck gives other economies. For example, Kaylo Tile's smooth under-side makes a completed ceiling as it forms the roof. The tile ceiling reflects light; requires no painting or other treatment. Get all the facts about Kaylo Insulating Roof Tile.

### FAST AND EASY TO INSTALL

A Kaylo roof deck can be constructed in only three steps: installing the sub-purlins, laying the tile and grouting the end joints. The deck is then ready for covering with standard built-up roofing materials. On these warehouse installations, barrel racks support the roof.

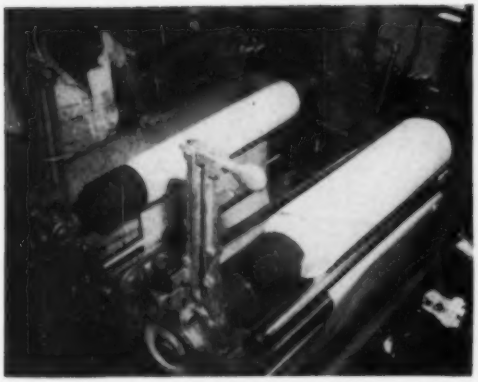


**WRITE FOR FREE BOOK**— "Kaylo Insulating Roof Tile." Address: Dept. N-260, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

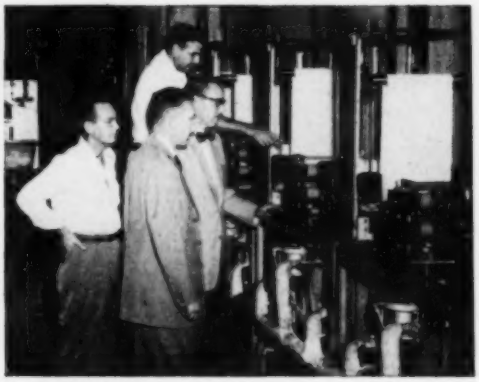
# KAYLO® ... first in calcium silicate

...pioneered by OWENS-ILLINOIS Glass Company

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BATCH acetylation, in lots up to 200 yd., is done on a dye jig.



CONTINUOUS processing is also adapted to acetylating cotton.

# King Cotton Is Modified

**Acetylated cotton—heat and rot resistant—looks ripe for marketing. Pilot scale processes are called ready for commercial projection.**

First it was wool fighting back against the onslaught of synthetics. Now King Cotton is rallying for the defense. The Southern Regional Research Laboratory has come up with commercially feasible processes for acetylated cotton, a fiber with a number of advantages including heat and rot resistance.

The regional unit of the Department of Agriculture has completed extensive laboratory work and a good deal of pilot-scale development on cotton modification processes. Six companies have investigated the processes and at least 50 have evaluated the partially-acetylated fiber.

Essentially, the treatment consists of substituting about one third of cotton's cellulose hydroxyl groups with acetyl groups (21.08 percent).

The laboratory has several commercial firms interested in the processes right now and if the modified fiber goes over, it may mean a market boost for acetic anhydride (principal reactant) plus an important advantage in cotton's competitive position.

▶ **Three-Step Process**—Here's how the pilot scale process works:

1. All non-cellulosic materials are removed from the cotton (starch, sizing, natural impurities). The fiber is boiled in 2 percent caustic for 7 hr. to remove the last traces of these impurities. Next the alkali-treated cotton is neutralized with acetic acid, rinsed well. After the cotton dries, it is allowed to pick up regain moisture.

2. Now the cotton is "activated." This consists of soaking in glacial acetic acid at room temperature for at least 4 hr. (The acetic acid in this step may be recovered, re-used.)

3. Then comes the acetylation reaction itself. The cotton is treated with a mixture of glacial acetic acid, acetic anhydride and small amounts of a 60 percent solution of perchloric acid which serves as catalyst.

In pilot-scale tests at the New Orleans laboratories of the Bureau, cotton fabric in lots as high as 200 yards at a time have been acetylated on a stainless steel dye jig (see cut) rigged up with an exhaust fan and cooling circulation of the reacting solution to and from the jig.

After treatment with glacial acetic, the fabric is transferred on a roll to the jig and the precooled reaction mixture (about 10 times the weight of the cotton) is pumped in. Usual composition of the mixture is 25 parts anhydride to 75 of glacial acetic acid, and 0.1 to 0.15 percent perchloric acid (60 percent solution) as catalyst. The fabric is passed back and forth through the solution. The reaction takes about an hour at 64 deg. F. (higher temperatures for faster reactions are not recommended) to reach 21-22 percent acetyl in sheeting, and 1.25-1.5 hr. in duck of 8 oz. per sq. yd. After reaction the fabric is washed and dried.

Result is a modified cotton with these advantages:

- Heat resistance (retains most of its original strength for days, even at 320 deg. F.).
- Rot and mildew resistance (far superior to cotton. Partially acetylated sand bags were still "in service" after standing on the ground for a year.)
- Lower moisture regain (about one-half that of untreated cotton).
- Resistance to chemicals (resistance to acids is improved).
- Greatly improved electrical insulating properties.

Some of the disadvantages of partially acetylated cotton are:

- Increased cost. Estimates are about $1 to $1.20 per lb. based on 40¢ for cotton. This makes it less expensive than most of the synthetics (nylon, Orlon, Dacron, Dynel) but more expensive than rayon.
- Impaired launderability (tests indicate alkaline laundry solutions are out).
- Like the synthetics, static is developed in processing.

Actually acetylated cotton is not new. It has been offered on a small commercial scale in England. But Southern Laboratory scientists believe that with feasible manufacturing and processing methods now accomplished, its success is now assured.

## Jefferson Will Produce Nonyl Phenols in Texas

A certificate of necessity has been granted to Jefferson Chemical Co., Inc., for construction of nonyl phenol and dinonyl phenol manufacturing facilities at its Port Neches, Tex., plant.

Nonyl phenol and dinonyl phenol are used as intermediates in the manufacture of anionic and non-ionic surface-active agents, as starting materials for lube oil additives, stabilizers, petroleum demulsifiers, oil-soluble phenolic resins and plasticizers.

# The light way to ship is in Continental Fibre Drums



Continental Fibre Drums are lighter in weight than any other shipping container of comparable strength. That means they can save you a substantial amount in shipping costs, at today's high freight rates. On shipments to countries where import duties are levied on the gross weight, these savings are even greater.

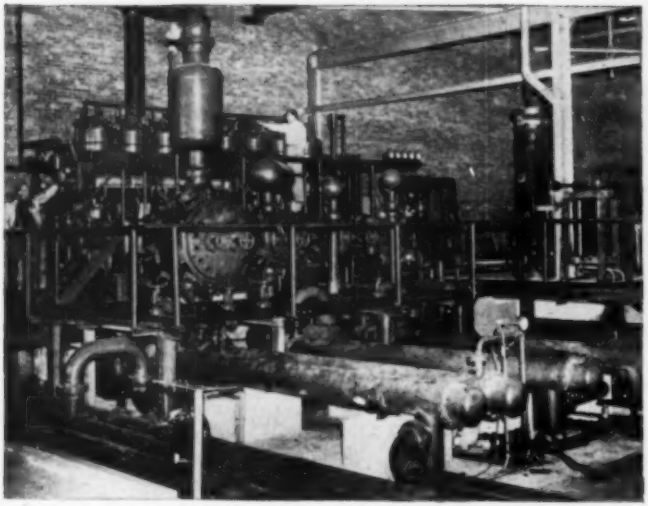
Although light in weight, Continental Fibre Drums are rugged and durable—will take rough handling. Thus you can give expensive or dangerous products all the shipping protection they need, without paying excess freight charges for heavy containers.

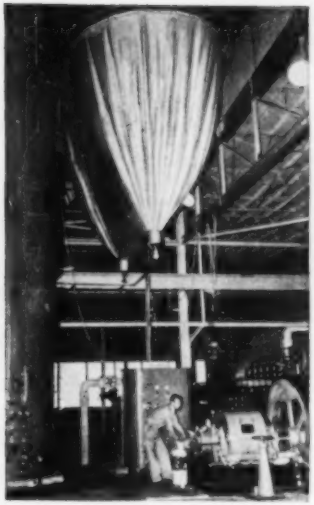
Neat and efficient in appearance, these drums can be attractively printed or spray painted to make an effective "traveling billboard" for your company or product. They come in a complete line of sizes, from 12 gallons to 75. Call the nearest Continental office for complete details.

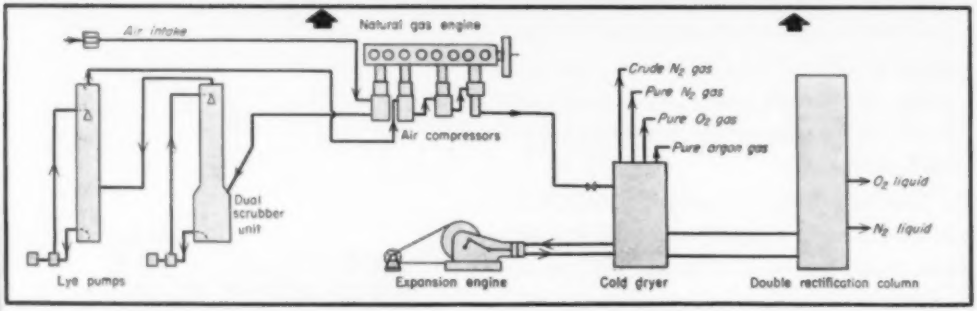
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# Houston Gets New Oxygen Plant

**It's the nation's most modern producer of pure oxygen, nitrogen and argon—the first plant of its type operated by an independent company.**

Rapidly expanding needs of the Southwest's industrial development inspired the building of Houston Oxygen Co.'s new $1 million plant for the production of pure liquid oxygen and liquid nitrogen, and pure oxygen, nitrogen and argon gases.

The project includes a 3-in. pipeline to supply local customers with pure, dry oxygen gas. The plant is situated so that additional pipelines can be run in various directions to supply other industrial areas which are growing up in its section of Houston.

The only thing simple about the manufacturing process is the free air which is the raw material. Air is filtered and the first stage of a five-stage compressor battery compresses it to 30 psi. It goes through dual scrubber towers and then the remaining compressor stages.

Having been compressed to 2,350 psi. the air proceeds to a cold dryer where moisture is frozen off under a temperature of −35 deg. C. It leaves in two parts, identified here as part A (about ¼ of the volume) and part B (the balance).

A heat exchanger cools part A to −150 deg. C. A liquefying exchanger cools it to −175 deg. Still under 2,350 psi. pressure, it passes through an expansion valve where it is expanded to 75 psi. This converts a high percentage to a liquid. Both the liquid air and the remainder of gaseous air then flow into a rectification column.

Meanwhile part B air also leaves the cold dryer at −35 deg. C. Still under 2,350 psi., it goes to a high-pressure expansion engine. Here the pressure is reduced to 75 psi., which lowers the temperature to −165 deg. C.

Part B air is cooled to −175 deg. in the same liquefying exchanger through which part A travels, but it is kept entirely separate. It then enters the rectification column.

The rectification column functions primarily as a double column. The lower portion is called the first rectification column, the upper portion is called the second rectification column.

From this second column pure liquid nitrogen is drawn off and stored in thermos flasks while pure nitrogen gas returns to the cold dryer before passing on to a gas holder. Oxygen




# This "Skin" never gives CORROSION a chance!

TODAY more than ever you need an effective program to fight corrosion in your plant. It can eat away your investment, knock out vital equipment that may be impossible to replace, and even interrupt your operations. Maintenance engineers everywhere are turning to Pitt Chem Tar Base Coatings for *better* corrosion protection at *lower* cost.

These versatile coatings are derived from coal tar pitch, one of our most impervious materials. Their heavy film—up to ten times as thick as ordinary paint—provides an impenetrable barrier to most mineral acids, alkalis, corrosive vapors and atmospheric conditions. And their low cost, ease of application and durability make them one of the most popular of all types of coatings.

Today, the name Pitt Chem is synonymous with *quality* in tar base coatings. For, as a *basic* and *integrated* producer of coal-derived products—situated at the very heart of the world's greatest coal deposits—we're able to control and maintain quality at every step of production, from coal to finished coatings.

Whether you're buying protective coatings, plasticizers, agricultural chemicals, or the products of any of our other integrated divisions, you'll find that it pays, *in every way*, to buy from a basic producer.

**PITT CHEM 101**
A versatile, heavy duty coating that withstands severest corrosive conditions.

**PITT CHEM 102**
A thin, high gloss maintenance coating for steel and concrete surfaces.

**PITT CHEM 103**
A heavy duty coating for metal exposed to corrosive vapors, dilute acids and alkalis.

**PITT CHEM 104**
A fast drying, high gloss coating for equipment handling potable water.

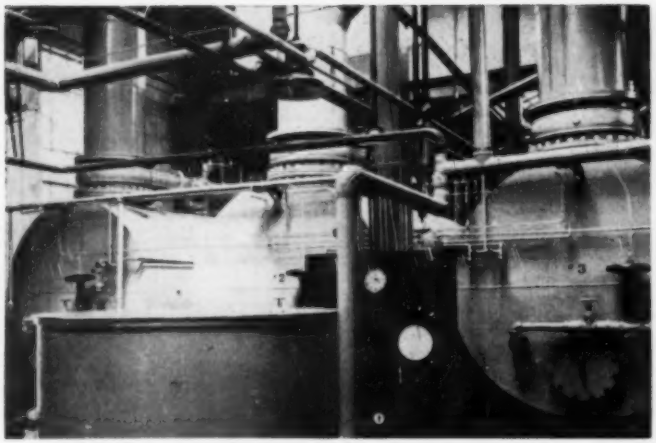
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SOLVENT RECOVERY
AND ODOR CONTROL

If your operation involves processes where solvents are lost by evaporation, chances are you need solvent recovery. In one processing operation a large amount of ethyl alcohol was being discharged to the atmosphere — involving considerable loss of revenue due to loss of the solvent, and creating a local hazard due to atmospheric pollution by certain phenolic bodies. An American solvent recovery system was installed, thereby preventing odor pollution. And, in addition, the resultant savings in recovered solvents enabled the system to pay for itself in less than a year.

American Solvent occupies a unique position in the allied fields of solvent recovery and odor removal, because we are the only manufacturer that both produces activated, coconut-shell carbon and fabricates the equipment, too. We can, therefore, offer you a completely integrated service, involving design and quality control for the entire system.

American Solvent also offers equipment for positive air purification and deodorization in any space ranging from small meat coolers to large office buildings. Pure Air units are self contained or can be built into the existing air conditioning system.

We'll be glad to discuss your problems and offer recommendations. No obligation, of course.

AMERICAN SOLVENT
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gases also pass through the cold dryer again before storage.

Crude argon gas coming from the rectification column is stored in a large balloon suspended under the roof of the building (see cut). It returns to a rectification system within the main column structure where it is brought to 99 percent purity. It then passes through the cold dryer unit and on to a gas holder.

Liquid oxygen goes from the second rectification column to two 1,000,000-cu.-ft. storage tanks. From these it can be pumped at 2,200 psi. to two evaporator heaters which convert it to large volumes of dry oxygen gas.

## Shell Acquires Maker Of Aldrin and Dieldrin

Shell Chemical Corp. has purchased Julius Hyman & Co., manufacturer of the insecticides aldrin and dieldrin. The Denver, Colo., firm will continue to operate under its present name.

Shell has also completed negotiations with the Velsicol Corp. of Chicago, Ill., for exclusive rights, worldwide, to the two insecticides. Shell Chemical Corp. has been exclusive marketer of aldrin and dieldrin since they were introduced commercially in 1950.

"Completion of our negotiations with Hyman and Velsicol," says President Jan Oostermeyer of Shell Chemical, "will insure that these widely used agricultural insecticides will continue to be available to the American farmer."

Aldrin and dieldrin have proved particularly effective against cotton insects, including the boll weevil. Dieldrin has also been used in the Rocky Mountain area in controlling the alfalfa weevil.

Last year, when Iran was combating its worst locust plague in 80 years, ECA had 13 tons of aldrin flown to Teheran. It was applied in a strength of only 2 oz. per acre. Yet within 24 hr. 98 percent of the locusts were killed, the plague was broken and the threat of famine erased. Palm trees, bent and sagging under the weight of locusts, straightened up soon after being sprayed, as dead locusts fell from them.

Aldrin has also been used against grasshoppers in the Rocky Mountain area, with only 2 oz. per acre required.

U. S. Department of Agriculture has just accepted for registration the use of aldrin against rootworms and wireworms, soil pests that attack corn, peanuts, small grains and sugar beets. Aldrin's chief advantage is its high potency per unit applied. It makes in-




Photomicrograph of Nalcite SAR spheres, designed for uniform liquid distribution, minimum channeling and bed packing.

*a new,*

## *STRONGLY BASIC ANION EXCHANGE RESIN*

USE of Nalcite SAR, strongly basic anion exchange resin, assures substantially complete removal of all acid-radical constituents from water and certain process liquids over a wide pH range (approximately from 2 to 10).

Where removal of weak acids, such as carbonic and silicic, has been a problem requiring elaborate techniques and additional equipment, Nalcite SAR provides a dependable, economical answer.

Other outstanding characteristics of Nalcite SAR, both physical and chemical, are detailed in the technical data booklet described at right. Ask for your copy today.

**Technical Data on NALCITE SAR**

**Bulletin 57 contains complete physical and chemical characteristics of Nalcite SAR, with sample calculations to enable rapid, accurate design of anion exchanger units. Data are correlated for simplified cross-reference. Information is given on typical plant operating results. Sent upon request, without obligation.**

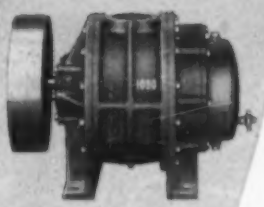
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*Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario*

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Typical low-capacity R-C Rotary Positive Blower. Sizes range from 5 cfm to 50,000 cfm, permitting selection closely matched to needs.

- ☐ Choice of Rotary or Centrifugal
- ☐ Capacity matched to the job
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- ☐ Ruggedness
- ☐ Ease of installation
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- ☐ Long-time durability
- ☐ Freedom from breakdowns
- ☐ Low maintenance costs
- ☐ Engineering assistance
- ☐ Proved reputation of maker
- ☐ Customer satisfaction

No need to take chances when buying blowers, exhausters or gas pumps. Just put this "detector test" to work on your specific problem and you'll arrive at the most satisfactory answer.

For instance, if you're debating between Rotary Positives and Centrifugals, remember that only Roots-Connersville builds both—the exclusive *dual-ability line* that permits unbiased recommendations. Their wide range of capacities supplies sizes and types that are quite likely to be most closely matched to your needs.

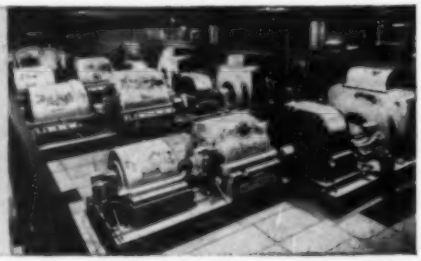
For economy of operation, reliability and low maintenance, we refer you to a list of users that dates back almost a century. If you'll rate your possible choices on a performance basis, you'll usually find R-C equipment "tops" on the list.

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Six R-C Multi-Stage Centrifugal Blowers equipped with automatic regulators to provide extremely wide range of operation at various pressures and capacities.



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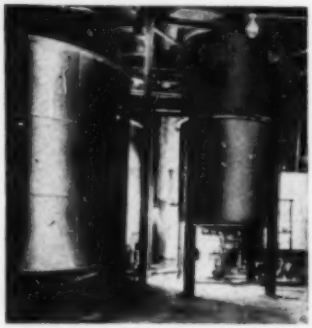
ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES




sect control possible at low cost. Dieldrin is even more powerful than aldrin and many new crop uses are expected for it.



## Unique Hydrogenation Plant Now on Stream in Canada

First plant in Canada for production of hydrogenated fatty acids and glycerides in the inedible field has just been completed at New Toronto, Ontario. It's a $100,000 enterprise of W. C. Hardesty Co.

The new hydrogenation equipment includes improvements developed through years of operating similar units at Hardesty's Dover, Ohio, plant. One man can operate the new unit. All process variables are automatically recorded and controlled from a central control panel.

Many new products are possible with this equipment. Hardesty has initiated a long range program of product development. For example, 12-hydroxy stearic acid, now used only in experimental batches because of its high price, may be produced economically in this type of unit. Also being explored: partially hydrogenated fats and fatty acids for specialized industrial uses.

## Perchloroethylene Unit For Diamond in Houston

Its chlorine-caustic capacity at Houston, Tex., will be increased 10 percent by Diamond Alkali Co. This added capacity is needed for the manufacture of perchloroethylene.

Originally, this increase was to have been part of the expansion program at Diamond's Painesville, Ohio, plant. But the company now plans to construct the perchloroethylene unit at Houston because of more favorable market conditions.

Meantime, Diamond has temporarily halted construction on its $12

million expansion project at Painesville so the program can be re-evaluated in the light of the Houston move.

The Painesville expansion, begun last year, was slated for completion in two years. If and when it's completed it will substantially boost output of chlorine and caustic soda by the electrolytic method. The perchloroethylene unit was expected to cost about $1 million at Painesville.

### Air Force to Reactivate Its Spent Silica Gel

Recently the economy-minded Air Material Command figured it could save on silica gel. It believed recovery of 3 million pounds of its annual 6 millions pounds consumption was possible.

Last month AMC signed a service contract with Eagle Chemical Co. The company will reactivate reclaimed silica gel using their own process.

The Air Force now pays 40 c. a lb. for its gel. It foresees a recovery for roughly 55 percent of the cost of new gel. Annual savings: $700,000.

Eagle's dehydration process, which can reclaim a gel up to nine times, requires no sulphuric acid. Production of new silica gel eats up a pound of sulphuric for 3 lb. of new gel. That means the Air Force will conserve about a million pounds of sulphuric acid.

Sale of used silica gel at all Air Force installations has been frozen. Disposal officers have been told to ship all used gel directly to Eagle.

### Briefs . . .

**More Phosphates:** Monsanto Chemical Co. has increased capacity to produce liquid 75 percent phosphoric acid, and crystalline monopotassium phosphate, diammonium phosphate and monoammonium phosphate. The products are used by fertilizer manufacturers to formulate liquid water-soluble plant foods.

**Cat Reformers:** Socony-Vacuum Oil Co. has licensed the Chemical Plants Division of Blaw-Knox Co. to use Socony's processes for the catalytic reforming of petroleum hydrocarbons. This supplements an earlier license to Blaw-Knox to design and build catalytic cracking plants using Socony-Vacuum processes.

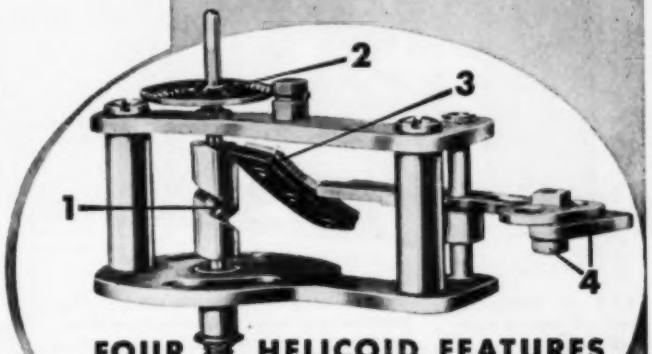
**Pair of Synthetics:** Naval Research Laboratory has come up with two low-cost materials for electrical insulation. One, a ceramic paper can be made by conventional papermaking methods from aluminum silicate or similar clay; it withstands 2,500 deg. F. when combined with bentonite, can be ma-


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The greatest achievement of the gage makers' craft—pressure gages without gears. The Helicoid movement... tested and proved in years of hard service . . . is a simple cam and roller arrangement that gives long, trouble-free service.




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• HELICOID GAGES, which do not have gear teeth to wear out, are made in a full range of pressures...in various sizes and shapes, with black, white and radiant faces. For wall or stem mounting, flush or panel mounting, or flangeless. No finer gages are made. Helicoid Gages cost less in the long run.

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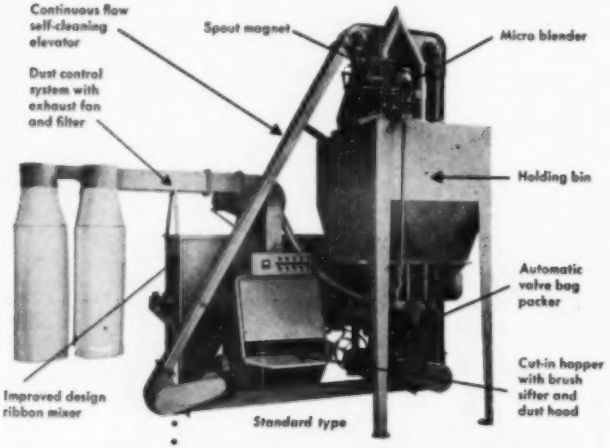
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*Complete* MIXING BLENDING PACKAGING *in one compact unit*

A. E. Poulsen & Company R.T.R.* **Uni-Blender**

**COMPOUNDING PLANTS**

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*R.T.R. is "Ready to Run" — Produce and Package

*For Formulating — Insecticides (Dusts and Liquids) . . . Industrial Chemicals . . . Prepared Food Mixes . . . Pharmaceuticals . . . Water Paints . . . Soap Powders . . . and a multitude of other materials*

**ADVANTAGES ACCLAIMED BY USERS**

Minimum space required—(Standard Type, 9' x 12' of floor space and 13' of headroom) • Maximum production per dollar invested in equipment • Reduced labor and other production costs • Proved, efficient performance wherever used • Every Plant factory-tested before shipment

**TYPICAL USER REPORT**—"The Poulsen R.T.R. Uni-Blender, Standard Type is the most perfect equipment for the manufacture of agricultural insecticide formulas due to its compactness, exceedingly high production, and extreme[illegible] operating cost."

**R.T.R. UNI-BLENDER COMPOUNDING PLANTS** are available in a wide range of production capacities.

Compounding plants are available for immediate shipment.

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chined or drilled. The other, called NaRel, resembles paper, drapes like cloth, is made of fine plastic fibers heated and sprayed onto a fine metal screen, then removed. This process eliminates critical papermaking or textile machinery. The product has higher dielectric strength than glass, withstands 250 deg. F., is water-repellent.

**Pipelines:** Continental Oil Co. and Sinclair Oil Corp., operating jointly, will install a 310-mi. petroleum products pipeline from Sinclair, Wyo., to Salt Lake City. With this decision, projected pipeline construction in Utah reached a $16 million mark.

## NITRIC ACID

(*Continued from page 179*)

In the first place, present agricultural and industrial demand for synthetic ammonia and converted ammonia products exceeds current supply. Such a situation reduces considerably the incentive for the nitrogen industry to make the necessary heavy capital investment in nitric acid plants or in equipment for processing phosphate rock with nitric acid. In fact, chrome steels which would be required in large quantity are little, if any, more available than sulphur, due to the defense program. This situation applies similarly to fertilizer manufacturers.

It may be reasoned further, if superphosphate supply is reduced by the sulphuric acid shortage, the demand for nitrogen ammoniating solutions will also be lessened, thus making nitrogen available as $HNO_3$. However, recent research by Solvay and others has indicated strongly that with proper control, the practical ratio of free ammonia to $P_2O_5$ can be considerably increased; in fact, sufficiently at least to overcome the contemplated reduction in superphosphate supply. In accomplishing this, the reversion of the $P_2O_5$ to agronomically unavailable form is increased little, if any. The full impact of this recent work has not been felt as yet in the fertilizer industry. It is evident that such a course would be much less expensive than investment in special equipment for utilizing nitric acid.

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1. Quanquin, M., "New Commercial Methods for Complex Fertilizers," *L' Industrie Chimique*, 34, No. 9, 165-7 (1947).
2. Walthall, J. H., "Chemistry and Technology of New Phosphate Materials," Short Course in Fertilizer Technology, Soil Society of America, University of Maryland, 1950.
3. Hignett, T. P., "Nitric Acidulation of Rock Phosphate," *Chemical Engineering*, May 1951, pp. 166-168.

"All Motors are NOT Alike"

# PRE-LUBRICATED BEARING DESIGN

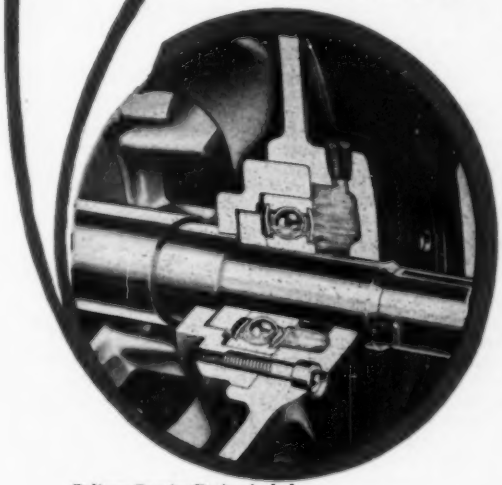
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# RELIANCE MOTORS

## provides more operating hours without re-lubrication!



*Reliance PRECISION-BUILT A-c. Motors from 3/4 to 300 hp.*



*Reliance Bearing Design, including extra-large grease reservoir, provides longer bearing life.*

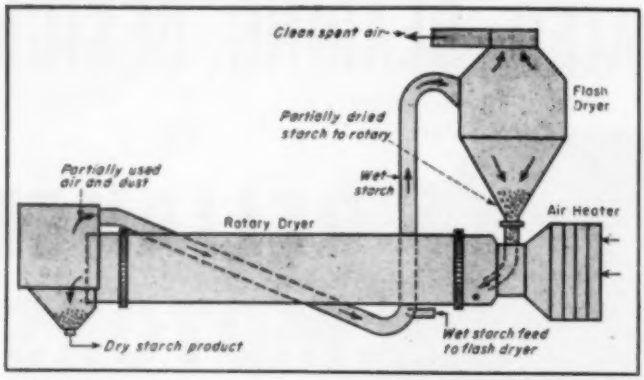
Original, factory lubrication permits more operating hours without re-lubrication than that of any other pre-lubricated bearing. From a larger grease reservoir than provided with any standard bearing, Reliance double-shielded bearings automatically take on new grease as needed. And the Reliance design not only *keeps* bearings lubricated, but makes it *impossible to overgrease* a Reliance Motor. Get the convenient chart on which you can check these and other features which combine to give you 15 important advantages in the Reliance Pre-lubricated Bearing Design . . . write today for Bulletin B-2201.




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# Readers' Views & Comments




**ROTARY-FLASH: Standard-Hersey system is one of three modern ways to dry starch.**

## Three Ways to Dry Starch

*Sir:*

In reference to the article in your March issue (p. 248) on the flash drying of starch, we would like to add some additional information that may interest your readers.

There are two continuous types of dryers now in general use in the starch industry.

One is a continuous belt-type dryer well engineered, well designed, and well thought of by its users. These include some very large starch manufacturers.

The second style is a rotary dryer. The foremost refinement of this second style is similar to that previously manufactured by the Hersey Dryer Division of Boston, now owned by Standard Steel Corp. in Los Angeles. Notice that the Standard-Hersey unit includes a rotary and flash stage (see cut). This system is also used by many large starch manufacturers.

The thermal efficiency of any dryer is a function of the incoming and outgoing air temperatures. We are not too familiar with the operation of continuous belt dryers, but we have every reason to believe they give high thermal efficiency—at least as high as the flash drying system you describe. Any simple rotary starch dryer will also have a thermal efficiency as high as a flash dryer.

The Standard-Hersey system designed and built by Standard Steel has a thermal efficiency definitely higher than that outlined and higher than every rotary system we have ever checked. This is because the cool gases contact the coldest and wettest material in a flash stage just before the air leaves the system.

The system outlined in your article is probably the first to use only flash drying for starch. The system devised by Hersey, which uses a flash dryer in one stage, is of well-seasoned vintage, having been designed and engineered at least fifteen years ago.

With regard to the two modern systems previously in use, to which must now be added this third modern system, each has its advantages and disadvantages.

To commence with, the belt-type dryer (and only the belt-type dryer) is capable of manufacturing a starch with pearls in it, i.e. little lumps of starch. This is desirable because many consumers have been conditioned to accept this type of starch since it was the kind which they obtained from old tray dryers. This system also has very little dust problem. However, initial cost is high.

In addition to higher thermal efficiency, the intermediate feed system has a great advantage over a single-stage flash dryer in that any drying system which includes a rotary parallel current stage is always easier to control. Also, very significantly, dust collection is no problem because dry fines are collected on wet feed, eliminating totally the necessity for a wet collection system. This gives the Standard-Hersey intermediate feed system low first cost compared to the flash dryer with wet collector.

With regard to operating labor, two Hersey dryers at United Sugar (to take one example) have a capacity of 5,000 lb. per hr. each of dry material and require less than one man per shift. They handle sweet potato starch and dry from 38 percent moisture.

NORMAN PITT
Research & Development Division
Standard Steel Corp.
Los Angeles, Calif.

▶ *Thanks, Reader Pitt, for an informative run-down on starch drying in general.*

*The system we reported at American Maize-Products is believed to be the first to use flash drying alone in starch operations. However, as Mr. Pitt points out, the combination rotary-flash system has been in use for many years by starch manufacturers throughout the country.*—ED.

## For Practical Men

*Sir:*

For my money, *Chemical Engineering* is a valuable publication which gives a broad outlook in the field of applied chemical engineering. It definitely has a spot in my line-up of magazines to be read for adequate information . . . complete coverage of new developments . . . intelligent choice of subject material. We in production work need a readable, practical magazine like yours to help us in our everyday problems in the plant.

M. L. LEITH
St. Louis, Mo.

▶ *Thanks, Reader Leith, and we're glad to know that our articles—which we try to keep practical—are helpful to you in your production work. CE is edited primarily for those people working in the "applied" phases of chemical engineering design, production, maintenance, development, safety and technical supervision.*—ED.

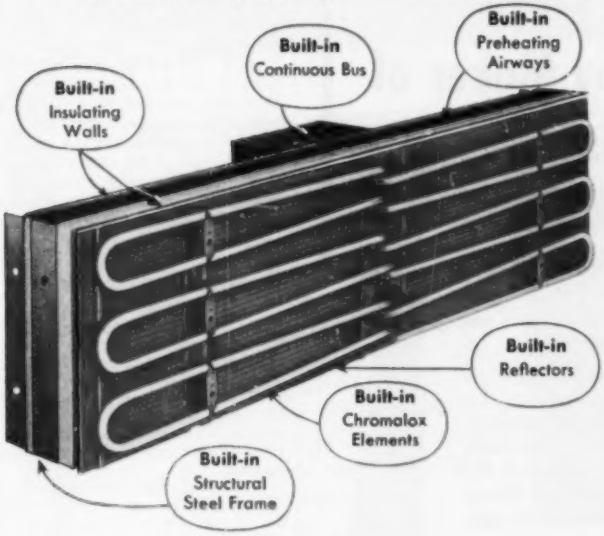
## Electrolytic $MnO_2$

*Sir:*

I was intrigued by the section on electrolytic reduction on p. 167 of the April issue of *Chemical Engineering*. The first item was the mention of electrolytic manganese by chloride electrolysis. The Bureau of Mines in its own reports does not draw the same conclusions as your editor did. As you probably realize, of the order of 20 million pounds a year new plant capacity for electrolytic manganese is now under construction.

The second item, on battery grade manganese, appears to overlook the fact that the Burgess Battery Co. during the last war, under the direction of Oliver Storey, operated an electrolytic manganese dioxide plant at Cartersville, Ga., from native ores. The steps

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## CHROMALOX *Electric* RADIANT PANELS

Now, more efficient *far*-infrared comes in convenient pre-engineered panels, reducing oven building to a matter of determining heat requirements and assembling panels to fit the job.

CHROMALOX Electric Radiant Panels generate more uniformly absorbed *far*-infrared heat with quick heat-up and reduced oven lengths.

It's the *far*-infrared wave length that makes the difference.

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- ✓ **Built to UL and NBFU requirements.**

## *Now...* Oven Building as Simple as A B C



It's easy to build ovens of any desired height and length with lightweight Chromalox Electric Radiant Panels. Panels come in 1 x 4 ft. and 2 x 4 ft. sizes, ready to erect and connect with easy-to-follow instructions in each carton. Chromalox on-the-spot engineering assistance to help determine your requirements is yours—no obligation, of course.

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*Does More - Better - Consistently*

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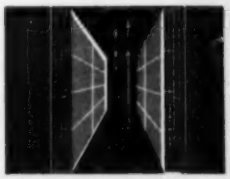
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*For Baking, Drying, Curing, Dehydrating*

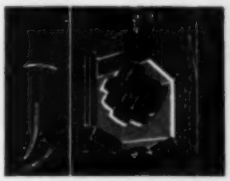
**and many other applications.**

## *9 WAYS BETTER*

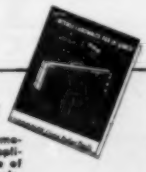
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IC-66

for men concerned with COLOR

# Pigment Costs Reduced 60% by Maker of Leather Finishes

A pure Indian Red was causing trouble for a company making leather finishes.

The company came to us stating that it was obtaining a wide range of color effects.

Our analysis of this company's formula revealed that the pigment was uniform . . . but it was too highly concentrated in relation to the amount of vehicle being used. As a result, there was insufficient vehicle in the final film to completely coat the pigment and fill the voids between the pigment particles. This gave an optical effect of darkening.

To cure this situation, we developed a new formula which called for a 60% reduction in the amount of Indian Red. Enough pigment still remained to give complete hiding . . . and the drastic reduction enabled the company to obtain the uniformity of color it was seeking.



LET WILLIAMS PUT THE MICROSCOPE ON YOUR COLOR PROBLEM

*Whatever your color problem, bring it to Williams. As shown by the example above . . . and many others in our files . . . Williams knows how to save you time and money on proper color formulation.*

**For complete technical reports, address Dept. 3, C. K. Williams & Co., Easton, Pa.**

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108 Metallic Oxide Pigments for Colors, Catalysts, Polishing Agents, Magnetic Materials.



of the process were identical with the ones you describe as being developed by Western Electrochemical and the Signal Corps. Instead of being a new process it is, at least in the manganese industry, quite a well known one.

Certain it is that the process as you describe it does not "permit for the first time the use of low-grade domestic ores." In addition, during the war years the Electro Manganese Corp. at Knoxville produced electrolytic manganese from low-grade ores, using your descriptive qualification as a definition. The question of the utilization of low-grade American ores is not one of process development but one which merely revolves around stern economic conditions.

C. L. MANTELL
Consulting Chemical Engineer
New York, N. Y.

► *We stated that "an economic comparison seems to be in order" for the Bureau of Mines chloride process for making manganese metal—thus deliberately took issue with the bureau's conclusion that no further study is warranted. To our way of thinking the chloride process has some interesting features that call for an economic analysis.*

*In our brief mention of the Schumacher method of producing battery-active $MnO_2$, we naturally gave no details. These have not yet been published.*

*There is evidence, however, that Schumacher's process does differ in a number of significant details from other similar methods that have been tried out in this country. In that sense it is new and—we believe—highly significant to our military operations.*—ED.

## What Was Your Score?

*Sir:*

Needless to say we appreciated, as always, your review of Vol. 8 of our "Encyclopedia of Chemical Technology" in your April issue. . . . How did your readers come out on the quiz?

DONALD F. OTHMER
Head, Dept. of Chemical Engineering
Polytechnic Institute of Brooklyn
Brooklyn 2, N. Y.

► *Managing Editor Pope's reviews of the now-famous Encyclopedia have always pulled high reader interest. The review of Vol. 8 that Dr. Othmer mentions (April, p. 319) included a "test yourself" true-and-false quiz. So far, not a single reader has laid claim to a perfect score.*—ED.

## FluoSolids Trademark

*Sir:*

In reviewing the article, "Direct Reduction in a Fluidized Bed," in your excellent April 1952 edition, our patent attorney has noted that on p.

# IDEA-CHEMICALS

. . . from Du Pont Polychemicals Department

## DU PONT CRYSTAL UREA

***Dentifrice formulations are only one of many uses for this versatile chemical***

Du Pont Crystal Urea, a pure white crystalline solid, is a vital ingredient in ammoniated dentifrices. It fights acid-forming food bacteria for several hours after teeth are brushed. It does this by releasing small, continuing amounts of alkaline ammonia which neutralize harmful mouth acids, thus helping to prevent the occurrence of dental cavities.

Du Pont Crystal Urea is profitably used in many other applications too—for example, in pharmaceuticals, adhesives, cosmetics, explosives, textiles, plastics, paper assistants and many other products. And Crystal Urea also offers undeveloped possibilities—in the manufacture of printing inks, insecticides and in petroleum refining, to name a few.



**Your business may find opportunities** for profitable future use in Du Pont Crystal Urea or in many of the other Polychemicals products. There are more than 100 of them—amides, alcohols, ammonia, organic acids, resins, esters, solvents and plastics.

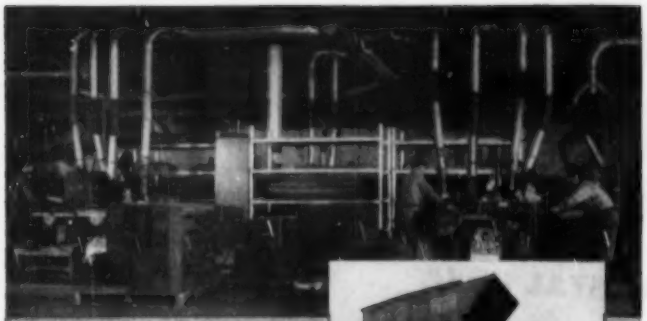
## Write for technical booklet on Polychemicals products for your industry

Technical bulletins on Crystal Urea and the chemicals and plastics used in your industry are available. Each product bulletin in the booklet presents physical and chemical properties, description, specifications, uses and possible applications, bibliography and other data. Write us on your business letterhead for your copy. We will gladly cooperate with you on any application for chemicals or plastics you would like to investigate. E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, 156E Nemours Bldg., Wilmington 98, Delaware.

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. . . THROUGH CHEMISTRY
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CHEMICALS • PLASTICS



Inlets, hoods and piping, engineered to fit the job, capture dust particles at the source, before they can escape to cause trouble and cost money.



Close-up of Pangborn Collector showing conical dust hoppers, dust storage bin and collector discharge duct.

**Pangborn presents Woodall* with "DUST to BURN"!**

***How Woodall Industries, Inc., uses Pangborn equipment to save $14,000 per year!**

Woodall Industries, Inc., Long Island, N. Y., produces Masonite panels in varying shapes and sizes for the automotive, railroad, television, and refrigeration industries, to name just a few. Shaping and drilling these panels produces Masonite dust—and plenty of it!

Without an effective system of dust control, Woodall workers would soon be knee-deep in dust. Thus, the Pangborn Dust Control System installed at Woodall would be essential at any cost. The beauty of the system, however, is that it *doesn't cost at all*—but actually pays its own way, with a nice profit to boot!

That's because this Pangborn Dust Control System not only maintains a dust-free plant, but also provides *all* the fuel for all heating and processing requirements, by conveying the Masonite dust from its source to a boiler furnace. Savings in oil alone have been figured at about $14,000 a year!

Add to this the savings in "housekeeping" costs, benefits in improved health and morale of employees—and you can see why Woodall is so enthusiastic about their Pangborn Dust Control System.

***What are your Dust Problems?*** Find out what Pangborn can do to solve them. Write today for Bulletin 909A. Address: PANGBORN CORPORATION, 2600 Pangborn Blvd., Hagerstown, Md.

*Look to Pangborn for the latest developments in Dust Control and Blast Cleaning equipment*

**Pangborn DUST CONTROL**

**STOPS THE DUST HOG from stealing profits**




168, second column, line 5, you have misused the word "FluoSolids." This word is an extremely valuable registered trademark of The Dorr Co., and we are most anxious to make certain that it does not fall into the public domain by being used in the generic sense in which you have used it in this article.

We are certain that the use was inadvertant, and would appreciate your care in the future in using this trademark. In place of "FluoSolids," we would suggest something like "fluidized solids."

ANTHONY ANABLE
Director of Public Relations
The Dorr Co.
Stamford, Conn.

▶ *We regret the inadvertant misuse of the trademark "FluoSolids" in our April issue. This trademark is owned by The Dorr Co. and is registered in the U. S. Patent Office.* —ED.

### Watch for More on Statistics

*Sir:*

. . . I particularly enjoyed Dr. Ferencz' article "Statistics Can Put More Meaning Into Your Cost Estimates" which began on p. 143 of your April issue. Could you give me the derivation of Dr. Ferencz' equations that appear on p. 144?

I would like to see more articles dealing with the applications of statistics to industrial problems. . . .

F. M. JACOBSEN
Ames, Iowa

▶ *To Reader Jacobsen and others interested in the subject: watch for a special report on Statistics late this year.*—ED.

### Rotating Hearth Furnace

*Sir:*

In your March number (p. 238) you were kind enough to publish an article dealing with the rotating hearth furnace as developed by our company. In order to complete the information given in this article, may we offer the following information about the development which has taken place.

Our company developed this furnace based on an idea of T. Ellefsen as protected by U. S. Patent 2,300,355. After having completed the preliminary studies in a 600-kw. furnace, we installed a 6,000-kw. open ferro-silicon furnace of this type at our Fiskaa works in Norway in 1937.

TVA installed the first fully enclosed furnace of this type for the production of phosphorus in 1946. In your article it is said that the TVA engineers "drew heavily on the experience of the Norwegians." This is not correct.

It is perfectly true that we advocated the building of closed furnaces of this type (several furnaces are now being installed). We also offered to TVA to design the experimental furnace for them. The TVA engineers, however, at that time had already nearly completed their design, and they installed the furnace practically on their own, adopting a lead seal between the roof and the rotating furnace, whereas we had proposed to them to install a sand seal. Also the details of the rotating mechanism is original for the TVA. We therefore take much pleasure in herewith recognizing the pioneering spirit shown by the TVA engineers that, through this installation, has contributed so much towards opening up this field for the rotating hearth furnace.

M. SEM

Technical Director
Elektrokemisk A. S.
Oslo, Norway

▶ *We appreciate the additional facts Dr. Sem passes along to us on the history and evolution of the rotating hearth furnace.*

*Core of our story in March was that National Carbide is now putting up two giant Elektrokemisk-designed covered rotating furnaces. They will be the first of their kind in the U. S. to produce calcium carbide.*—ED.

### Methanization

*Sir:*

In the April issue (p. 163) it is stated that Mississippi Chemical Corp. uses synthesis pressures of 1,000 atm. for methane reforming at 730-930 deg. F.

Apparently you meant methanization instead of methane reforming. Methanization is generally carried to convert traces of carbon monoxide which poison the ammonia synthesis catalyst to inert methane.

W. B. INNES

American Cyanamid Co.
Stamford, Conn.

▶ *Yes, we certainly meant methanization instead of methane reforming.*—ED.

### STACKS—I, II, III

*Sir:*

I should like to take this opportunity to compliment you for publishing the three articles on "Stacks for Pollution Control" by S. R. Steinbock.

R. K. VANDERVORT

Mechanical Engineering Dept.
New York State Electric & Gas Corp.
Binghamton, N. Y.

▶ *Interest in Mr. Steinbock's series of articles has been high and many readers have expressed reactions similar to those of Mr. VanDervort. A revision of some of Mr. Steinbock's data appeared in our May issue (p. 290).*—ED.

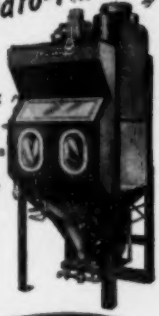

NOW! Pangborn Stock Units for Blast Cleaning... Dust Control... Precision Finishing

Blast Clean with this Portable Unit!



Ideal for maintenance and many other jobs, including removal of rust, dirt, scale, etc. Economically cleans large objects like tanks, bridges, structural work before painting. Six sizes, stationary or portable, from .... $170.00 and up.

Speed Polishing with Hydro-Finish!



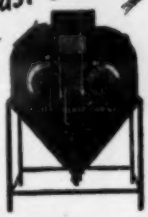
Removes scale and directional grinding lines . . . prepares surfaces for plating and holds tolerances to .0001"! Liquid blast reduces costly hand cleaning and finishing of molds, dies, tools, etc. Models from $1410.00 and up.

Stop Dust at the Source!



Pangborn industrial type Unit Dust Collectors trap dust at source. Machine wear is minimized, housekeeping and maintenance costs reduced. Solves many grinding and polishing nuisances and material losses. Models from $286.00 and up.

Clean Small Work in this Blast Cabinet!



Ideal for producing smooth, clean surfaces on pieces up to 60" x 36" in size. Cleans metal parts, removes rust, scale, dirt, grime, paint, etc., in a few seconds. Saves money all year 'round. Models from . . . $319.00 and up.

*Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment*

Pangborn — MAIL COUPON FOR DETAILS

Check for more information
- ☐ Blast Cleaning Cabinets
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- ☐ Unit Dust Collectors
- ☐ Hydro-Finish Cabinets

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Gentlemen: Please send me more information on the equipment I've checked on the left. To be used for_____
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# *Automatic*

# MIXED BED DEMINERALIZING



Permutit Mixed Bed Demineralizing installation in a midwestern television manufacturing plant, produces water with a total electrolyte content of less than 0.2 ppm and silica of 0.05 ppm. Most commercial *distilled* water contains from 2 to 10 ppm electrolytes —yet distillation costs far more than demineralizing for average water supplies.

The Permutit Mixed Bed Demineralizer is a single ion-exchange unit containing both anion and cation exchangers in homogenous mixture. This combination provides a maximum number of individual demineralizing steps, so that mineral impurities are reduced to the vanishing point. In fact, conventional water analysis methods cannot even determine accurately the minute remaining quantities. The purity of such treated water must be determined by conductivity and spectrophotometer measurements.

Mixed Bed Demineralizing units usually contain Permutit Q, a sulfonated styrene type cation exchange resin. The anion exchanger most used is Permutit S, a highly basic quarternary amine anion exchange resin which removes acids including silicic acid from solution.

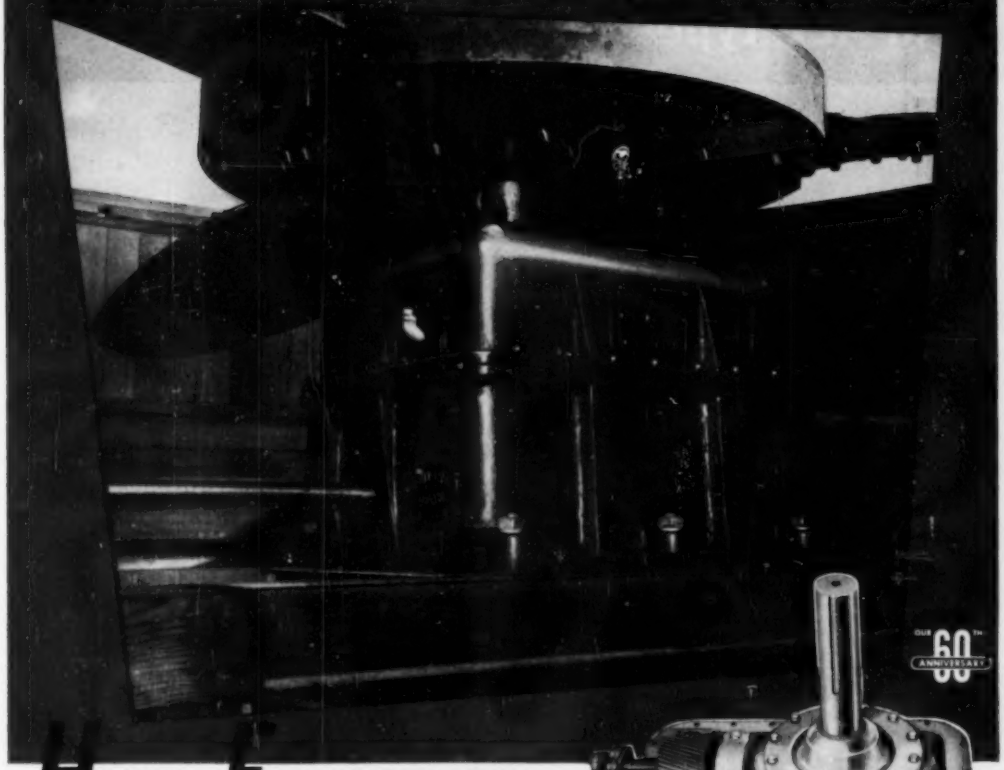
Now this useful treating method is available, designed for fully automatic operation by the foremost manufacturer of automatic water conditioning equipment.

For further details, write to The Permutit Company, Department CE-6, 330 West 42nd Street, New York 36, N. Y.

**PERMUTIT**

ION EXCHANGE HEADQUARTERS FOR 40 YEARS

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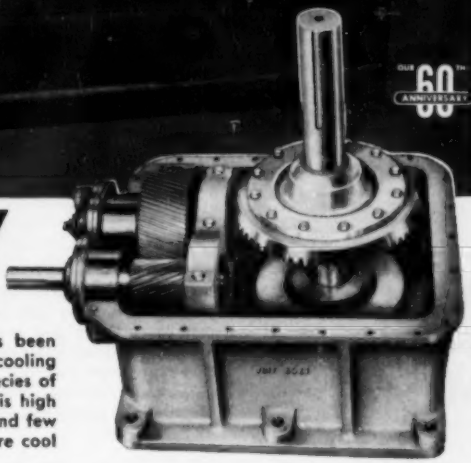
# HIGH EFFICIENCY

### CUTS POWER LOSS

The Philadelphia Spiral-Bevel Cooling Tower Drive has been developed to transmit the heavier fan loads of today's cooling towers. Many of these units are now operating at efficiencies of 97-98% under the most severe operating conditions. This high efficiency means minimum power loss, less maintenance and few oil changes during the long life of the reducers. Units are cool operating.

A wide range of sizes are available for every cooling tower application.

The drive shown above is on a cooling tower designed and built by Hudson Engineering Company. It is typical of many such installations.



Construction features of the Philadelphia Spiral-Bevel Cooling Tower Drive are given in Bulletin CT-51. Write on your business letterhead for a copy.

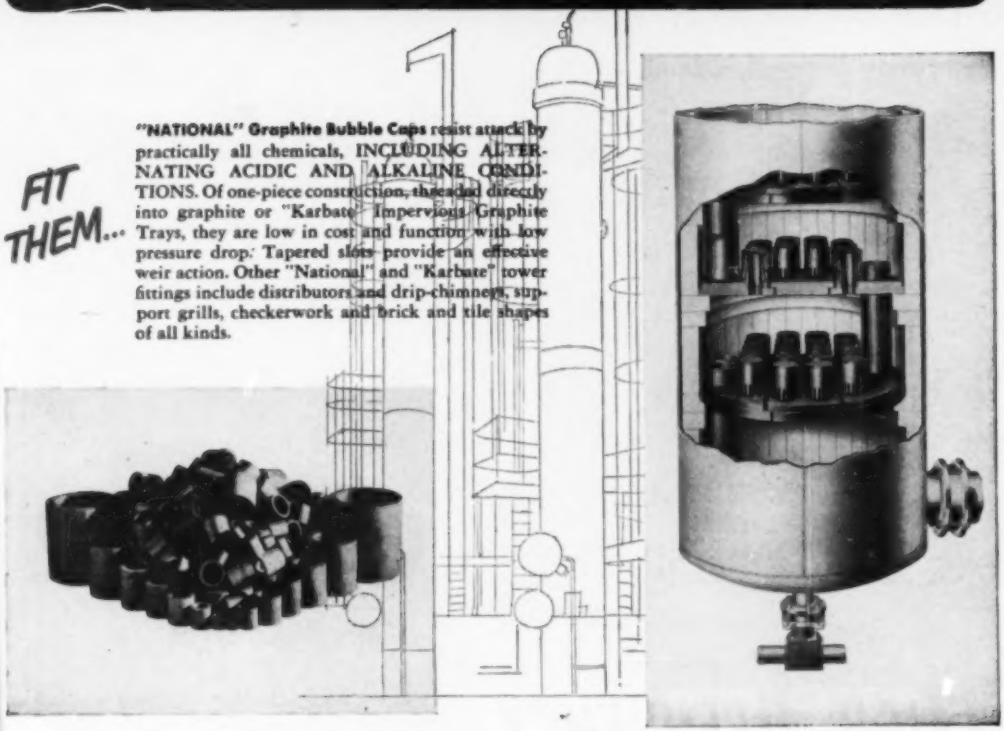
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*Industrial Gears and Speed Reducers*
*LimiTorque Valve Controls*

# For low-cost, trouble-free service in ALL types of tower construction



*FIT THEM...*

**"NATIONAL" Graphite Bubble Caps** resist attack by practically all chemicals, INCLUDING ALTERNATING ACIDIC AND ALKALINE CONDITIONS. Of one-piece construction, threaded directly into graphite or "Karbate" Impervious Graphite Trays, they are low in cost and function with low pressure drop. Tapered slots provide an effective weir action. Other "National" and "Karbate" tower fittings include distributors and drip-chimneys, support grills, checkerwork and brick and tile shapes of all kinds.

*and PACK THEM...*

**"NATIONAL" Carbon Raschig Rings** are immune to acid, alkali, and solvent action; have extremely low coefficient of thermal expansion; are light-weight and strongly resistant to chipping and spalling. They have a very attractive overall cost and long service-life. Eight sizes range from ¼" to 3" O.D. Very popular in reaction and scrubbing towers used by the chemical, petroleum and petro-chemical and processing industries.

*with* **NATIONAL CARBON AND GRAPHITE AND "KARBATE" IMPERVIOUS GRAPHITE TOWER ACCESSORIES**




***Low light bills...***

. . . mark phenomenal acceptance of the "EVEREADY" No. 1050 Industrial Flashlight Battery by a broad cross-section of industry. Delivering *twice the usable light* of any battery we've ever made before, it will not swell, stick, or jam in the flashlight . . . has no metal can to leak or corrode.

*The terms "National", "Karbate" and "Eveready" are registered trade-marks of Union Carbide and Carbon Corporation*

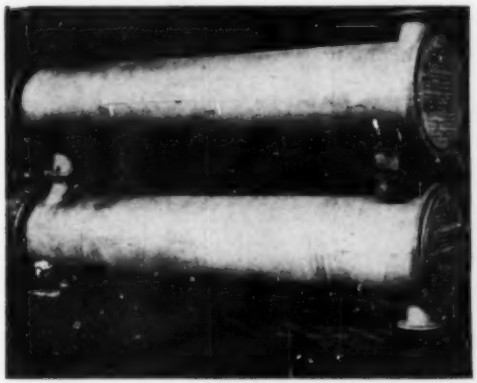
**NATIONAL CARBON COMPANY**
**A Division of Union Carbide and Carbon Corporation**
**30 East 42nd Street, New York 17, N.Y.**

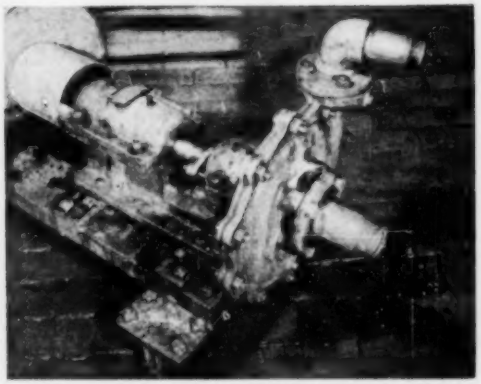
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OTHER NATIONAL CARBON PRODUCTS

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**Tubes, sheets, and jackets of the twin heat exchanger unit shown at the left are all made of Hastelloy C. Service: aluminum chloride-hydrochloric acid process stream, with sea water as the coolant. At right is a Hastelloy C pump for handling dye intermediates.**

# Hastelloy Alloy C

**The corrosion resistance of this nickel-molybdenum-chromium alloy to over 150 corrosives, with data on mechanical properties, forms available and applications.**

**EDWARD D. WEISERT**
**Haynes Stellite Co., Kokomo, Ind.**

Hastelloy alloy C is a high-strength structural alloy that has excellent resistance to a wide variety of corrosive media. Alloy C is a nickel-base material containing molybdenum and chromium. It retains, to a large extent, the corrosion resistance of nickel–molybdenum alloys to non-oxidizing agents. Addition of chromium imparts general resistance to oxidizing conditions as well. Detailed chemical composition of the alloy appears in Table I.

The alloy is available in wrought form as hot-rolled sheet, plate and bar stock; also as welded tubing, drawn wire, welding rod and coated electrodes. Pipe fittings, pump parts, and similar parts are supplied as conventional sand castings or as precision-investment castings. Table II gives some of the mechanical properties of the alloy in both cast and wrought form.

Hastelloy alloy C is machinable and can be readily fabricated by most common methods. It has high room-temperature ductility and good weldability. Heliarc welding is generally the preferred method for joining the alloy. Metallic-arc, atomic hydrogen, and other welding processes can also be used. When severe forming operations are performed on alloy C, intermediate annealing treatments are usually necessary to relieve the stresses that result from cold working, and to restore ductility. To insure optimum corrosion resistance, finished units should be fully annealed at 2,225-2,250 deg. F. before they are put in service. This treatment fully stress relieves the unit and dissolves all constituents except the primary carbides. Annealing should be followed by a rapid quench in water or air. If the unit has been welded, it is desirable to soak is for a minimum of one hour at temperature to break up the cast structure of the weld zone.

The twin heat exchanger, shown above, is typical of the versatility of Hastelloy alloy C. The tubes are used to cool an aluminum chloride-hydrochloric acid stream from styrene production. Since the plant is located in a coastal city, sea water is used as the coolant. Many alloys would resist the corrosive effects of the process stream, but would be subject to pitting and corrosive attack by the sea water. In the unit above, the tubes, tube sheets, and jacket are all Hastelloy alloy C, because it successfully resists the corrosive stream and also the sea water. Tests at Kure Beach, N. C., have shown that Hastelloy alloy C is essentially immune to attack by salt water. In a 10-year exposure of both cast and wrought specimens, alloy C showed no pitting or crevice corrosion. The corrosion rate of the wrought specimen was only 0.01 mils per year, and for the cast specimen 0.04 mils per year.

Besides its excellent corrosion resistance, Hastelloy alloy C also has good high-temperature properties. It is being used extensively in applications where good hot strength is the primary

(*Continued on page 312*)

**Table I—Chemical Composition of Hastelloy Alloy C**

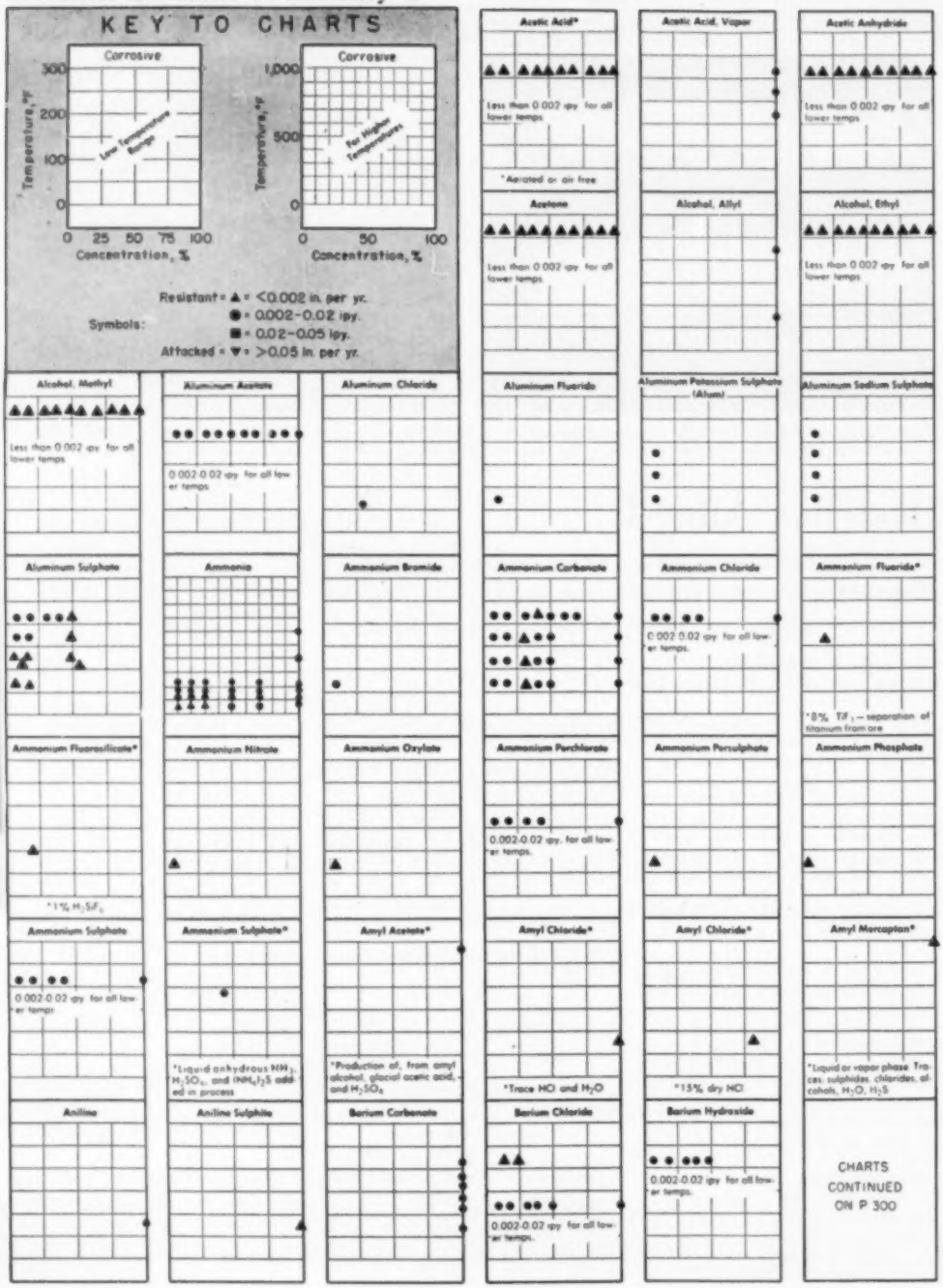
| | % | | % |
|---|---|---|---|
| Mo | 16-18 | Mn | 1.0 max. |
| Cr | 15.5-17.5 | Si | 1.0 max. |
| Fe | 4.5-7.0 | P | 0.04 max. |
| W | 3.75-4.75 | S | 0.03 max. |
| C | 0.15 max. | Ni | Balance |

**Table II—Mechanical Properties of Hastelloy Alloy C**

(Room Temperature)

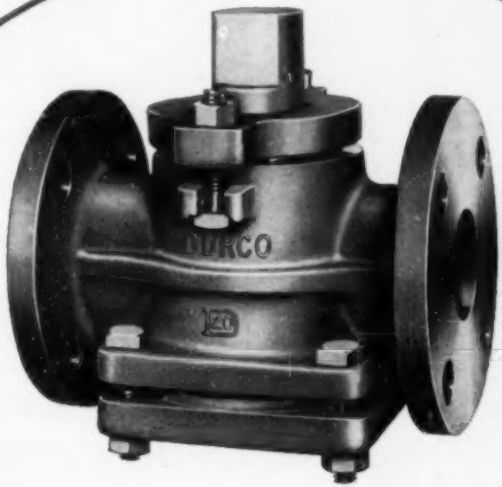
| | Wrought | Cast |
|---|---|---|
| Ultimate strength, psi. | 120,000-140,000 | 73,000-83,000 |
| Yield strength, psi. (0.2 percent offset) | 52,000-58,000 | 55,000-60,000 |
| Elongation, percent | 40-30 | 5-10 |
| Hardness, Rockwell | B-92 to B-98 | B-90 to C-22 |
| Impact strength, ft.-lb. | | |
| Izod | ... | 5-13 |
| Charpy (V-notched) | 60-65 | ... |
| Modulus of elasticity, psi. | 28,500,000 | 28,000,000 |

## Corrosion Resistance of Hastelloy C




CHARTS CONTINUED ON P 300

NON-STICK




NON-LUBRICATED

**Available in Durimet 20, Durco 18-8-S-Mo and a wide range of other Durco stainless alloys.**

# DURCO TYPE F VALVE

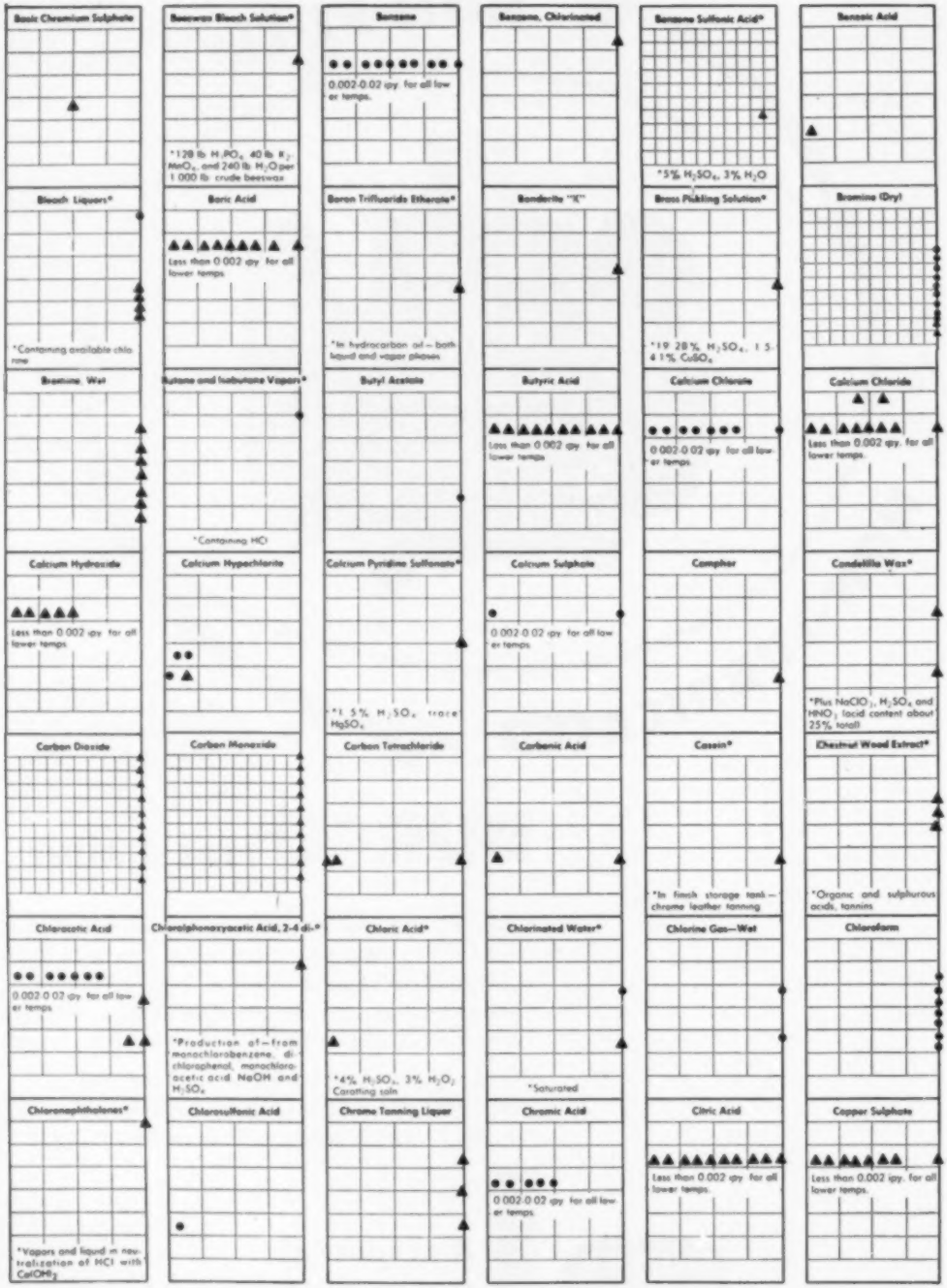
When you buy a valve, you're mainly interested in trouble-free performance. This valve gives it to you—in the toughest kinds of chemical service. There are thousands in use. Yet, no case of sticking has ever been reported, despite the fact that no lubricant is used.

The reason is the Teflon sleeve—and the basic design that makes it practical to use. Sizes ¼" through 2". Other details in Bulletin 647.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

**A product of**
**THE DURIRON COMPANY, Inc.**
**Dayton, Ohio**

**Corrosion Resistance of Hastelloy C (cont.)** Key to charts on p. 298.




(Continued on page 302)

# There are many waterfalls but . . . *only one* Niagara



# There are many coatings but . . . *only one* INSUL-MASTIC

INSUL-MASTIC pioneered heavy coatings—of *superior* quality. Years of thorough testing and experimentation, by corrosion plagued chemical companies, proved conclusively that long term protection against acids, alkalis and weather was at long last possible, through the use of INSUL-MASTIC.

The government confirmed this finding—INSUL-MASTIC being the only mastic coating ever approved under the original rigid specification for "mothballing" the war materiel.

INSUL-MASTIC *superior* coatings brought about changes in coating specifications throughout industry. The extremely long life and very low moisture vapor penetration rate of INSUL-MASTIC were the qualities that industry was seeking in its fight against corrosion and moisture penetration. The proven formulae which brought this enduring protection are patented and *cannot be duplicated* . . . there is only *one* INSUL-MASTIC.

Tests by the National Bureau of Standards and other impartial laboratories* prove the value of INSUL-MASTIC's basic ingredients for increasing coating life. Those ingredients are a maximum percentage of Gilsonite and *carefully* chosen mica and asbestos.

INSUL-MASTIC Vaporseal Coatings will prevent corrosion under severe chemical conditions, and will vaporseal insulation or building walls.

INSUL-MASTIC Type "D" Insulation will control condensation or prevent 65% of heat loss.

There is only *one* INSUL-MASTIC—Write for the name of our nearest licensee.

*Think first of the coatings that last!*

* *Names on request*

**Insul-Mastic Corporation**
OF AMERICA
1156 OLIVER BUILDING · PITTSBURGH 22, PA.
Representatives in Principal Cities





# Who's Kidding Who?

**YOU'RE kidding YOURSELF if you think every safety valve is equally safe.**

We know of one case where inspection showed that 27 out of 36 safety valves were stuck tight—*would not have operated at pressures far above the set point*—yet the user of those valves *thought* he had protection. He *could* have been stuck right along with those 27 valves.

If you want 100 per cent safety—and you'd hardly want less—there's one sure way to get it—specify BalanSeal or FarriSeal Safety Valves.

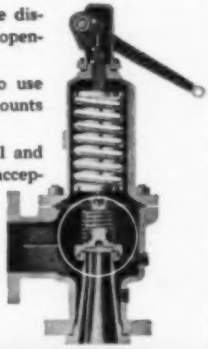
**Why?** Because they *can't* stick, plug or corrode. Critical working parts are permanently isolated from any contact whatever with the lading.

Because they're unaffected by back pressures in the discharge manifold due to its own operation or to the opening of other valves in the line.

Because these features make it possible for you to use smaller discharge piping, an economy which often amounts to substantially more than the cost of the valves.

You'll be interested in the engineering of BalanSeal and FarriSeal Valves—design which is rapidly gaining acceptance in hundreds of successful installations.

**Ask for our "8-Minute Brief."**



1189 R

**Your Safety's REAL With FarriSeal**

**Farris ENGINEERING CORP.**

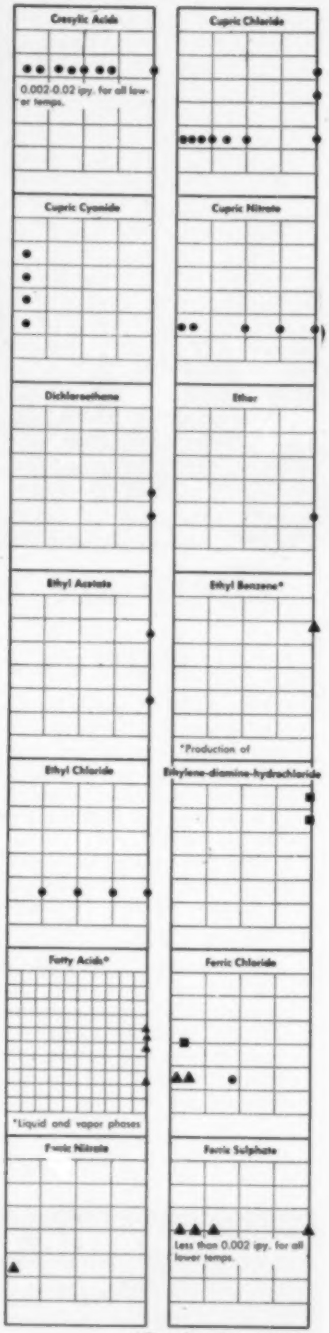
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AFFILIATES

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Hastelloy C (key on p. 298)

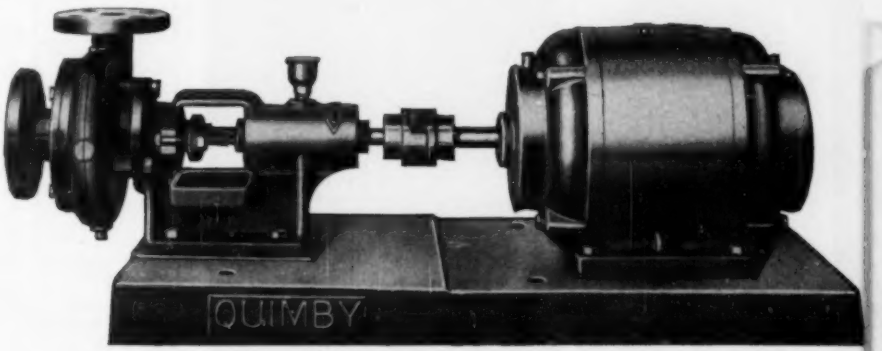



(Continued on p. 304)

FOR PROCESS AND MEDIUM DUTY CHEMICAL SERVICE

# dependability and economy are assured

## with this Warren-Quimby Type "G" Pump




This Warren-Quimby Pump is designed to give both dependable and thoroughly economical satisfaction in process industries and chemical plants having semi-critical requirements. It has proven its merit conclusively whenever correctly applied.

Simplicity of design, sturdy bearings, extra deep stuffing box, tapped catchall, together with strong construction throughout the entire rigid assembly, all contribute to long, useful life at moderate cost.

It is available in 1, 1¼, 1½, 2 and 3 inch discharge sizes. Capacities up to 400 GPM—heads up to 240 feet.

WARREN QUIMBY PUMPS

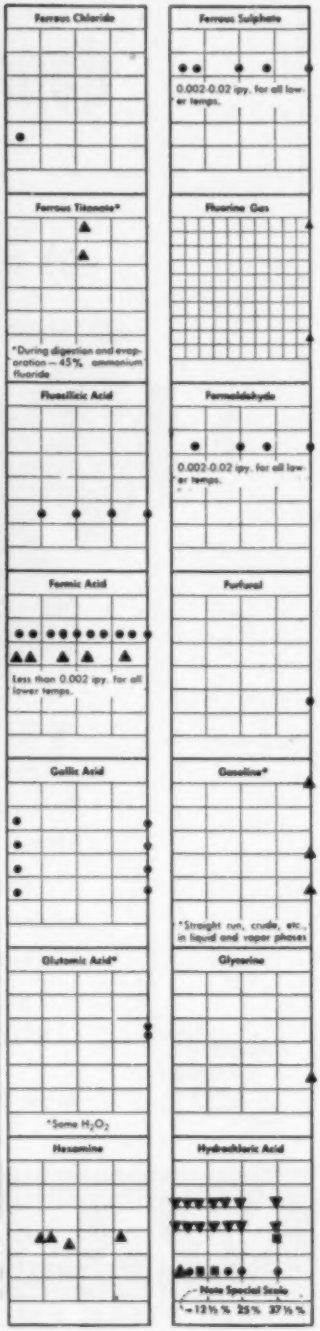
*SEND FOR BULLETIN WQ-213 giving Specifications, Selection Chart, etc.*

CD-4

**WARREN PUMPS**

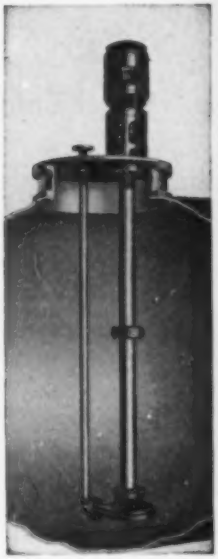
**WARREN STEAM PUMP COMPANY, INC., WARREN, MASSACHUSETTS**

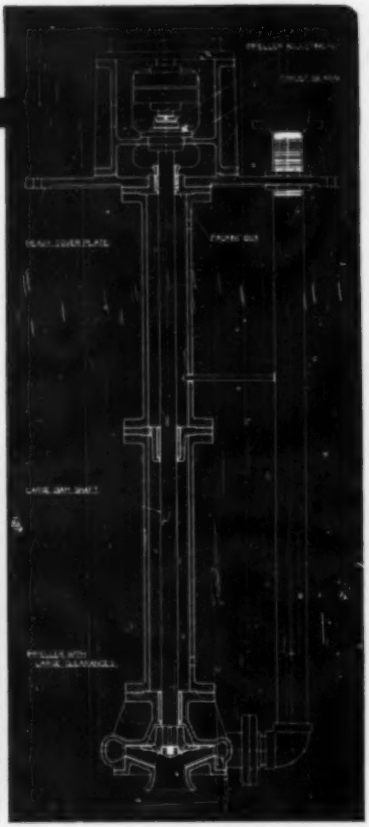
Hastelloy C (key on p. 298)





*(Right)* Structural details of Lawrence Vertical Chemical Pump. *(Below)* Vertical Chemical Pump mounted inside of tank.





# VERTICAL CHEMICAL PUMPS

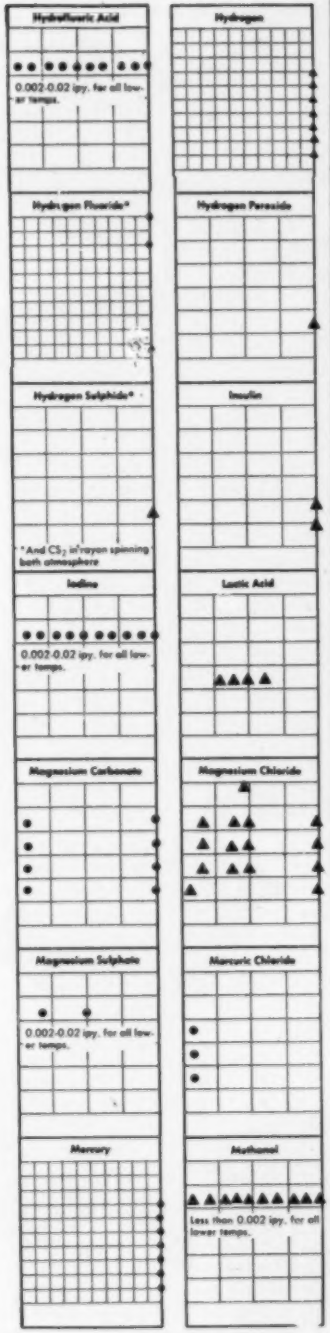
Difficult chemical pumping problems—handling hot concentrated acids, corrosive alkalies, molten salts, molten sulphur, volatile semi-fluids, etc.—have been a LAWRENCE specialty for over 80 years.

To meet the demands of this rigorous service, LAWRENCE Vertical Chemical Pumps are made of metals or alloys carefully chosen to give the best protection against the corrosive and abrasive action of the liquid pumped, as well as structural strength and long wear. Other design features (depending on the circumstances) include liquid seals for high vacuum, the elimination of packing, mounting bearings above the level of the liquid pumped to prevent contact, and many more refinements that contribute vitally to efficient, trouble-free operation.

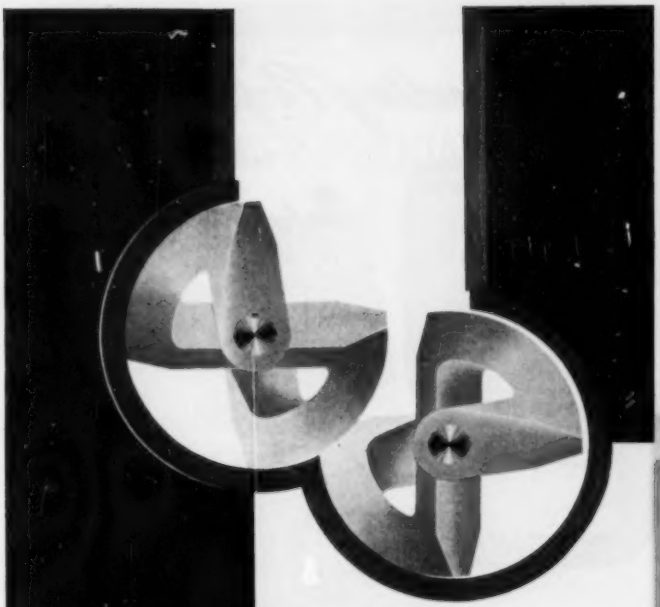
If you have a particularly difficult chemical pumping problem, write us the pertinent details.



LAWRENCE
MACHINE & PUMP CORPORATION
369 MARKET STREET, LAWRENCE, MASS




(Continued on p. 306)

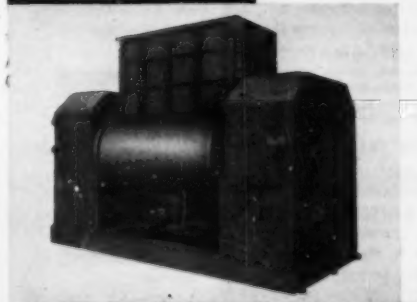
when the **HEAT'S on...**

for increased production involving heat transfer, the Readco Double-Arm Jacketed Mixer offers definite advantages.

Its unique bowl design provides a greater ratio of heated surface to the volume of mix. Close clearances between the mixer arms and shell eliminate build-up of materials, permitting increased heat transfer efficiency.

Overlapping sigma arm mixing action exposes new surfaces and breaks down the entire mass with each rotation, producing a homogeneous mix in a short mixing cycle and eliminating peak loads.

The flush-plug discharge gate prevents accumulation of dead volume. It can be supplied for manual, hydraulic or pneumatic operation.



Bakery-Chemical Division:
YORK, PENNSYLVANIA
LOS ANGELES 39, CALIFORNIA




# EXPLO-SAFE

## MOTOR STARTERS

## FOR ALL HAZARDOUS LOCATIONS

### APPROVED BY UNDERWRITERS' LABORATORIES

***Just ⅔ the weight*** **means faster, easier installation with Arrow-Hart's new EXPLO-SAFE magnetic starters. Hanging requires less support giving new opportunities for more convenient layout. Size has been reduced by ⅓, too, allowing more compact control centers. Exclusive straight-thru front wiring means quicker, easier wiring and servicing. EXPLO-SAFE will provide better protection for all your hazardous location installations without the inconvenience of cumbersome, outmoded solenoid starters. The revolutionary "RA," Right Angle, balanced operating mechanism not only permits valuable savings in weight and size, but also assures outstanding performance and dependable, low maintenance operation. Remember — there's an EXPLO-SAFE starter for every installation. Starter and contactor sizes 0, 1, 2, 3, 4 are now available in NEMA Type VII (Explosive Gas), Type IX (Explosive Dust), and Type IV (Weatherproof).**

**HERE IS IMPORTANT INFORMATION**

**This illustrated booklet fully describes all the important operating advantages of the new EXPLO-SAFE motor starters. Complete with dimensional and rating data. It will be mailed without cost or obligation.**

**SEND TODAY FOR YOUR FREE FOLDER**




**THE ARROW-HART & HEGEMAN ELECTRIC CO.**
INDUSTRIAL CONTROL DIVISION
2606 Hawthorn St., Hartford 6, Conn.

Please send me "EXPLO-SAFE" MOTOR STARTER folder.

YOUR NAME _____

POSITION _____

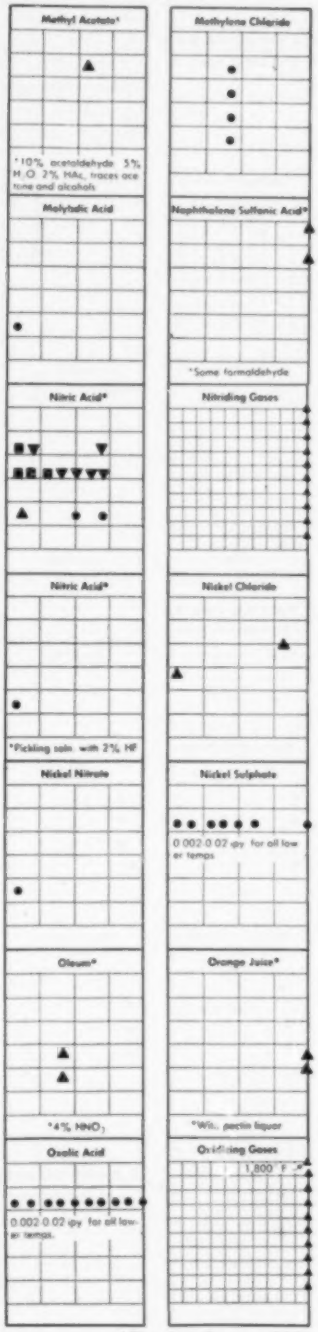
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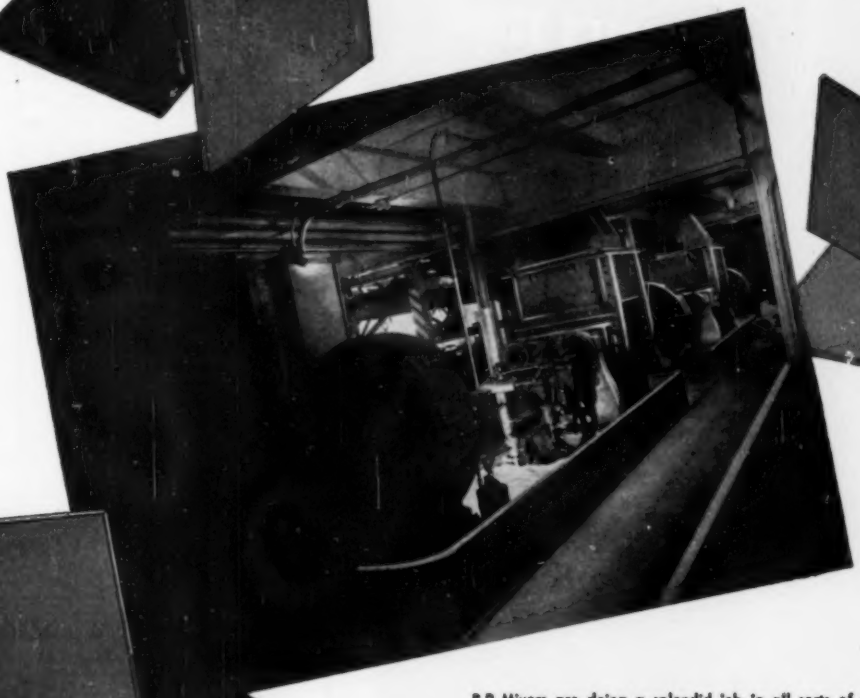



Hastelloy C (key on p. 298)




(*Continued on p. 308*)

# Colorful asphalt floor tile mix uniformly produced in BAKER PERKINS mixers



B-P Mixers are doing a splendid job in all sorts of processing operations, and this installation of six size 15JSE BAKER PERKINS Mixers at a large asphalt floor tile plant is an excellent example. These six mixers can thoroughly blend the ingredients for asphalt floor tile at the rate of 18,000 lbs. per hour on a continuous production schedule. Like other BAKER PERKINS equipment, the cost of operating and maintenance, including labor, material handling, power, and depreciation, are down where they should be. BAKER PERKINS equipment can help cut costs, increase production, and improve the quality of your product, too. Consult a B-P sales engineer or write us today.

**BAKER PERKINS INC.**

CHEMICAL MACHINERY DIVISION

SAGINAW, MICHIGAN



# Fabrication at its best COMES FROM EXPERIENCE

## STAINLESS STEEL and other Alloy Metals

are fabricated by Littleford to care for the ever-increasing need for specialized equipment in the Chemical Industry. Equipment that is strong, tough and resistant to corrosion.

To produce this type of product takes the skill of craftsmen who have had experience in laying out, shearing, forming and welding of Alloy Metals. Littleford had this experience and has produced equipment from Stainless Steel, Monel, Nickel, Aluminum, Everdur, and Inconel since their inception. Tanks (Plain and Code), Bins, Vats, Kettles, Tables, Troughs, Hoppers, etc., are only a few of the many products now in use.

70 years' experience in the fabricating of metals plus a definite responsibility for the finished product is why Littleford can offer a service which is second to none.

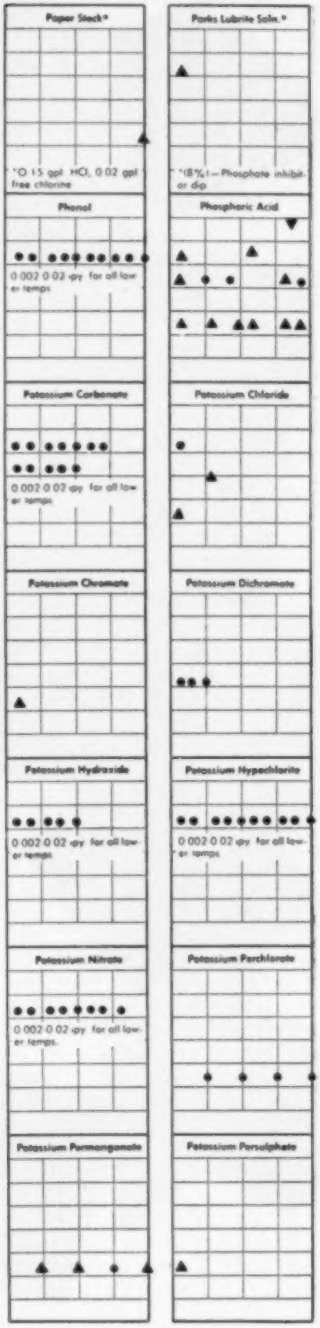
If you have a problem involving Alloy Metals send blueprints to Littleford, see for yourself how these years of fabricating know how can cut your costs for specialized equipment. Send for Alloy Fabricating Bulletin.

LITTLEFORD

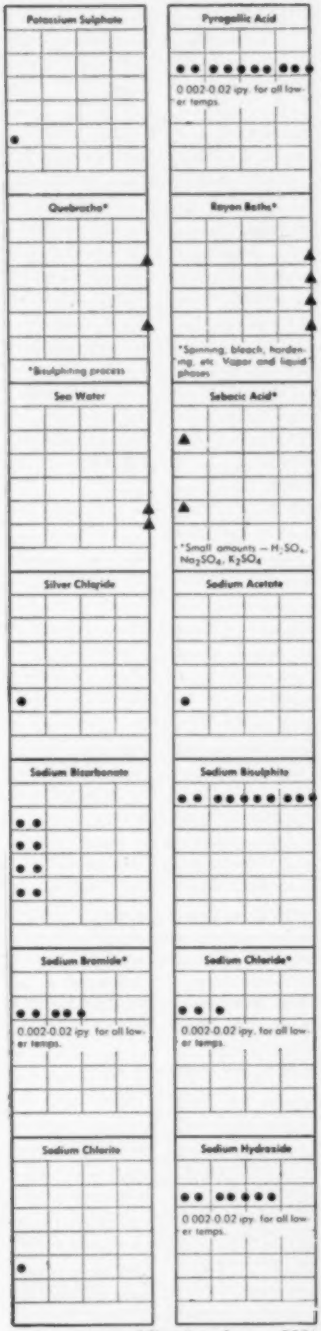
LITTLEFORD BROS., INC.
421 E. Pearl Street, Cincinnati 2, Ohio




Hastelloy C (key on p. 298)



Hastelloy C (key on p. 298)




(Continued on p. 310)


# THE NEW FOSTER 50-G2

## Pressure Reducing Regulator



## IS A NATURAL

**It combines extremely close regulation and high inlet-to-outlet ratio, under varying loads — approaching *instrument control* — with the freedom from trouble, long life and easy maintenance of a *regulator*.**

## Here's Why:

Although the new 50-G2 is single-seated for tight shut-off, it has the throttling action of a double-seated valve. Full balanced pilot valve and short travel of operating steam to the main valve piston cut the lag in response, for extremely close following of the demand. Yet overtravel, flutter and chatter are eliminated by the mass of the piston, stabilizing multi-rings, and unrestricted area under the piston.

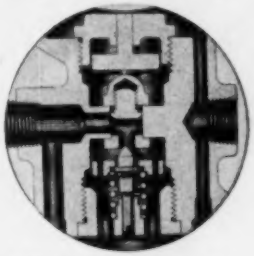
Pilot valve opening *with* the flow minimizes deadhead loss, and permits higher inlet-to-outlet ratio, for instance, 250# to 2#. May eliminate intermediate stage in low pressure applications such as deaerating water heaters, tank storage heaters and auxiliary exhaust systems.

All wearing parts are of stainless, corrosion and erosion resisting materials. New alloy metals mean less wear.

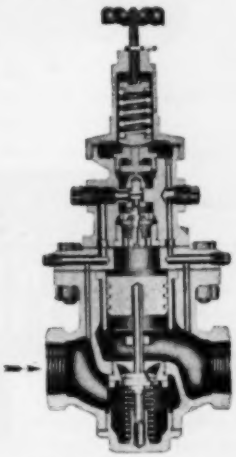
No special tools are needed for servicing, and no outside media are required for operation.

Available for initial pressures 25—1200 P.S.I.G.; temperatures to 950°F; reduced pressures from controlled vacuum of 15" HG. to 600 P.S.I.G. with minor changes in top assembly; sizes ½" to 12".

For full information, ask for Bulletin G-101.



50-G2 Auxiliary or Pilot Valve Unit

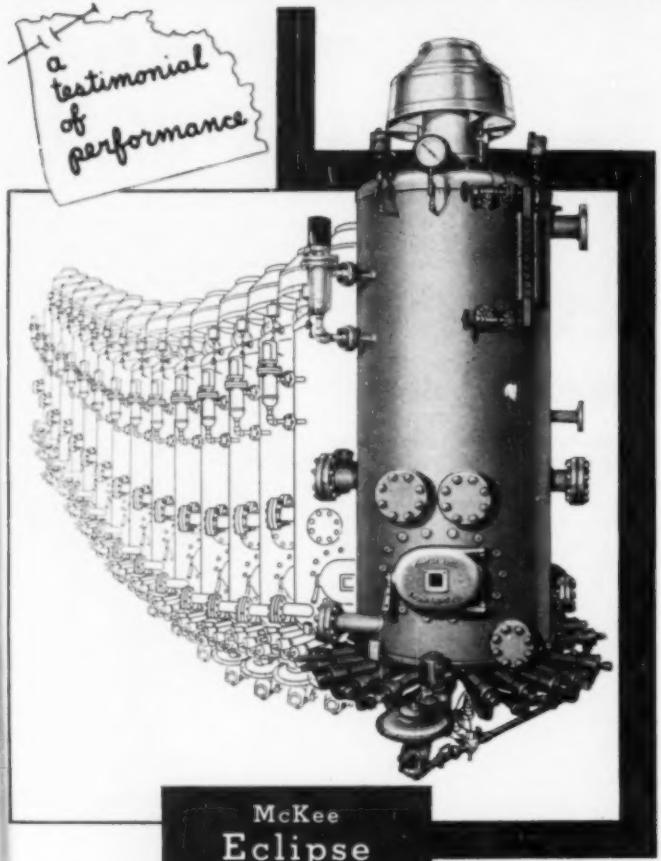


Foster Type 50-G2 Internal Pilot Operated Pressure Reducing Regulator with Standard Top Assembly

## FOSTER ENGINEERING

PRESSURE REGULATORS . . . RELIEF AND BACK PRESSURE VALVES . . . CUSHION CHECK VALVES . . . ALTITUDE VALVES . . . FAN ENGINE REGULATORS . . . PUMP GOVERNORS . . . TEMPERATURE REGULATORS . . . FLOAT AND LEVER BALANCED VALVES . . . NON-RETURN VALVES . . . VACUUM REGULATORS OR BREAKERS . . . STRAINERS . . . SIRENS . . . SAFETY VALVES . . . FLOW TUBES

# 15th ECLIPSE DOWTHERM UNIT
## for this chemical company




McKee
Eclipse
DOWTHERM
VAPORIZERS

This 1,000,000 BTU Eclipse Dowtherm Vaporizer is Gas-fired and fully automatic.

**for Processing Resin**

THIS CHEMICAL MANUFACTURER expanding production, has just added the 15th duplicate Eclipse Dowtherm Vaporizer . . . a practical indication of his high opinion of these Industrial Process Units. If you have any application such as melting, cooking, deodorizing or other process heating it will pay you to investigate the economy, controllability and safety of High Heat—Low Pressure Eclipse Dowtherm Vaporizers. Choose from Vertical or Horizontal, 30,000 to 3,500,000 BTU; Gas, Oil or Combination. Write for Bulletin or consult SWEET'S Product Designers or Process Industries Catalog, and Chemical Engineering Catalog.

*REPRESENTATIVES IN ALL PRINCIPAL CITIES*

**Eclipse Fuel Engineering Company**
1121 Buchanan Street, Rockford, Illinois

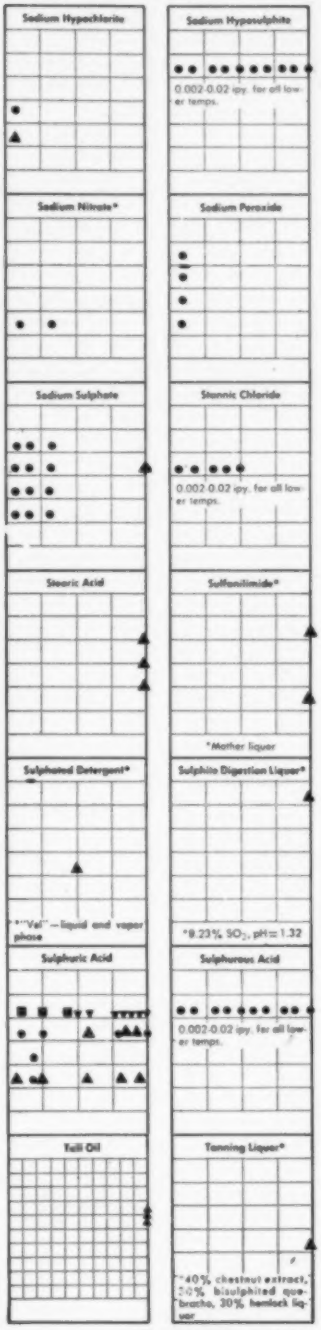
McKee Eclipse

5919

THE MOST COMPLETE LINE OF INDUSTRIAL HEATING EQUIPMENT




Hastelloy C (key on p. 298)




(*Continued on p. 312*)

# 100 temperatures recorded

*by One*

# Speedomax recorder



Esso

phenol extraction unit
Bayonne, N. J.

It would take six 16-point recorders—each with its own chart—to give the same information which is concentrated on the one chart of the 100-point Speedomax Recorder shown above. Reading one chart instead of six saves time—a busy man can check temperatures more often. The danger of mistakes resulting from a comparison of six separate charts is eliminated.

**Minimized Cost Per Thermocouple Point**

Instrument cost per point recorded is less than that for any other L&N recorder! Panel space is reduced by two-thirds. Scanning of 100 points during a heat balance check requires only six minutes, forty seconds. If, like Esso, you are interested in only 20 of the 100 temperatures as long as the process is operating smoothly, you can read them in only 80 seconds.

You need not provide for 100 thermocouples unless you need them, since instrument capacities range from 40 to 160 points. Four types of operation are always at hand:

1. **Continuous Indicating but no Recording.** All points are indicated in succession.
2. **Automatic START-STOP.** In this type of operation, a specified temperature limit is set. As long as no thermocouple point exceeds this limit, the Speedomax simply indicates. But if any point should exceed the limit, automatic recording of all points begins and an alarm is sounded to summon the operator. Thermocouple connections are grouped in banks of 20, and a different temperature limit can be set for each bank.
3. **Continuous Recording.** Automatic recording of all points.
4. **Selective Indicating or Recording.** Indicating or recording of any bank, combination of banks, or single point.

To get more facts, write our nearest office, or 4916 Stenton Ave., Phila. 44, Pa. Ask for Folder ND46-33A(1).

LEEDS LN NORTHRUP

Jrl Ad ND46-33-702(3)

# *Portable* MOISTURE METER

***insures product uniformity . . . cuts costs!***

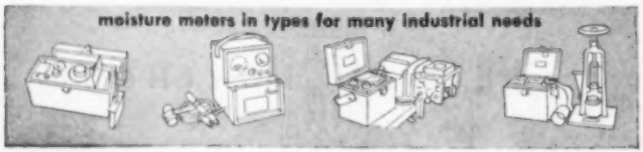


## TAG Midget MOISTURE METER

In the manufacture of coated abrasives, too much moisture in the backing material during processing, or too little moisture, can have costly consequences. Non-uniform flexing . . . paper delamination . . . mold . . . or even bonding failures. So this leading manufacturer checks moisture content every step of the way with simple, accurate TAG moisture meters. They state, "portable TAG meters have enabled us to attain a more uniform product, and eliminate product losses due to improper moisture content."

In many other products and processes, too, incorrect moisture content is costing real money. Why not consult with TAG on your moisture problems now. Or, ask for literature on the various types of moisture meters available . . . WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J., *manufacturers of Weston and TAG instruments.*

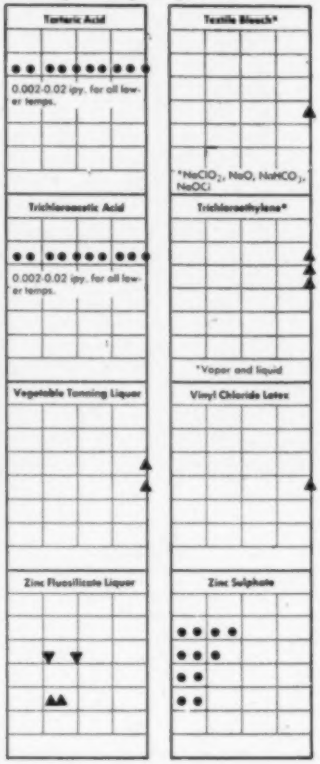
WESTON **WESTON** *Instruments*







**Hastelloy C** (Key on p. 298)




## HASTELLOY C

*Continued from page* 297

requirement, as well as in applications where elevated operating temperatures are combined with corrosive conditions.

The temperature-concentration charts herewith indicate the universal corrosion resistance of Hastelloy alloy C. The data presented are generally reliable. However, such charts can serve only as rough guides, to obtain a starting point from which to make an intelligent choice of a material for a given service. The value of such a presentation of corrosion data is in narrowing down the possible materials for a particular application. The effects of aeration, galvanic coupling, contaminants, and erosion encountered in actual operation must be considered before a final choice is made. Carefully planned and executed field tests are the best means of determining the service a material will give under certain operating conditions.



# STRETCH OUT YOUR STAINLESS, TOO

There *are* ways to stretch out your supply of stainless.

For example, you may be using a grade or finish of stainless that is in extreme demand when another similar one, not as tight, could do the job adequately.

Our metallurgical staff and stainless fabricating specialists are ready to help you look into this matter and to advise you on more readily-available types of stainless that will do a satisfactory job. Feel free to call on us for this specialized help.

**CRUCIBLE** first name in special purpose steels

*52 years of Fine steelmaking*

**STAINLESS STEEL**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REZISTAL STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

# What's Ahead in Corrosion Prevention

**What you can expect in the way of extensions and improvements in cathodic protection, coatings of various types, deaeration, inhibitors, etc.**

**HERBERT H. UHLIG**
**Massachusetts Institute of Technology, Cambridge, Mass.**

It is a reasonable prediction that billions of dollars lost each year through corrosion of metals will gradually diminish through increasing application of science and technology. Cathodic protection, applied widely to the protection of thousands of miles of buried pipelines, to marine structures, and to industrial tanks, will inevitably find diversified use in the chemical industry. Examples include protecting chemical reaction vessels and piping; also equipment constructed of corrosion-resistant alloys, the latter being satisfactory from the standpoint of general attack but subject to failure by stress corrosion cracking, intergranular corrosion, or by pitting.

In the field of metal coatings, research effort can be expected to make electrodeposited coatings pore-free—hence, more protective where coatings are noble in potential to the base metal. These will include composite alloy coatings of nickel, molybdenum and iron having properties similar to the Hastelloys and, hence, resistant to several mineral acids. Also, metal coatings produced by high-temperature gas phase reactions forming Si-Fe, Cr-Fe and possibly other alloys should find a variety of uses. For outstanding resistance, titanium is one of the important coming metals. Because of expense, it perhaps will be first applied as a clad material on steel. Its inherent resistance to oxidizing or non oxidizing chloride solutions, including salts like ferric chloride, will make this metal potentially valuable to many chemical operations.

Wash primers are slated to meet expanding popularity, because they save labor in the painting of metals. In one operation, they produce a phosphate undercoat affording the necessary bonding, together with a prime coat which contains a corrosion-inhibiting pigment. Top coatings using some of the newer chemical-resistant plastics and having reduced permeability to moisture and oxygen are wholly possible, so that with good adherence and lower permeability, better corrosion protection can be expected of future paints.

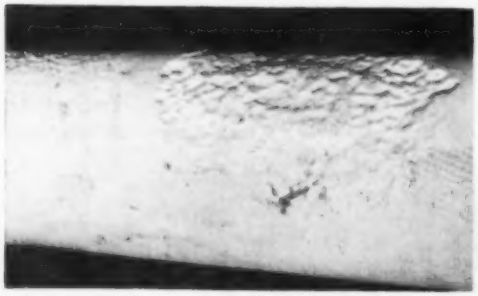
Inexpensive glass coatings combined with cathodic protection will be used more widely for piping and tanks. This combination, for some media, offers economic advantage over the present glass coatings that must be perfectly pore-free and over cathodic protection alone applied to a bare surface.

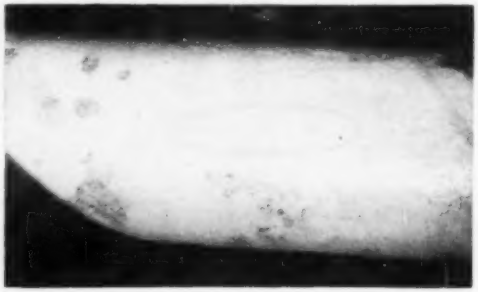
The market for certain corrosion inhibitors will greatly expand when they are added generally to automotive oils and gasolines. When this happens, the life of engines should be improved by a sizeable percentage. It is estimated, for example, that 60 percent of present engine wear is caused by corrosion of piston rings and cylinder walls by combustion products.

Vacuum deaeration for reducing the oxygen content of industrial and municiple waters, thereby making the water less corrosive to steel and other metals, promises a good future. This will solve, among other things, some of the difficulties with galvanized hot water tanks and piping in soft-water areas, or where water has been softened by exchange resins and zeolites.

Presently available together with new corrosion-resistant alloys are bound to find increasing welcome by the chemical industry. The steady trend toward more severe operating conditions has accentuated demands for better metals. In addition, many industries are discovering that higher initial costs are likely to be offset in short time by prolonged life and better performance.

Finally, the new profession of corrosion engineering is destined to come into its own, if indeed it has not already arrived. The reason is twofold—first, because corrosion losses of even medium-sized industries may amount to millions of dollars per year and, second, because the science and technology of corrosion control has advanced to the point where an impressionable saving in annual losses can now be guaranteed. In addition, the particular contributions which the corrosion engineer can make to the design of new factories, new processes and new machinery are becoming a "must."



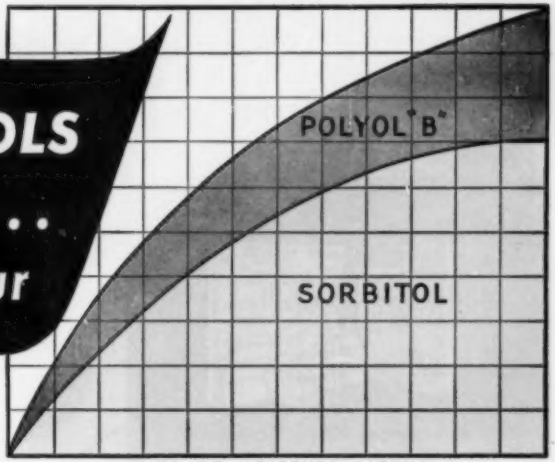


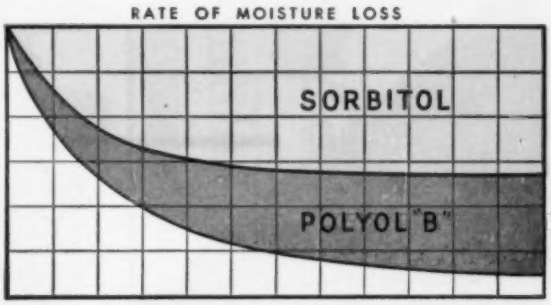
**Where It Paid to Sandblast**

Above are two sections of the same pipe at the Harbor Island, N. C. corrosion testing station of the International Nickel Co., exposed to salt water spray.

Each section received about 2 yr. ago 3 coats of vinyl-base paint. Section at left was sandblasted. Coating is in perfect condition despite the distinct irregularities in the base metal. Section at the right was flame-cleaned and wire-brushed. Several breakthroughs are evident.

# BUY POLYOLS ON FACTS... Compare all four




**FACT No. 1** ***Sorbitol for Narrow Humectant Range***

Atlas sorbitol picks up less moisture and loses less moisture—at a slower rate—than other commercial polyols. Your products will retain their saleability better under all humidity ranges when they are conditioned with sorbitol.

**FACT No. 2** ***Sorbitol for Economy***

On price stability alone, sorbitol rates as the "best buy" in polyols. Its price trend through the years has been steadily downward. Still another price reduction recently has been made. Ask about it.

**FACT No. 3** ***Sorbitol for Availability***

Sorbitol is derived from sugar which is available in almost unlimited quantities. You don't need to worry about shortages of sorbitol or its derivatives.

Write today for the valuable 22-page Atlas sorbitol book containing charts, usage tables, and other helpful data. Personal technical assistance is available at your request.

*Industrial Chemicals Department*

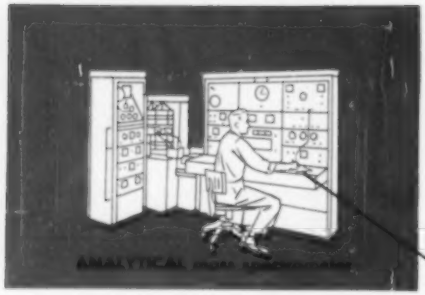
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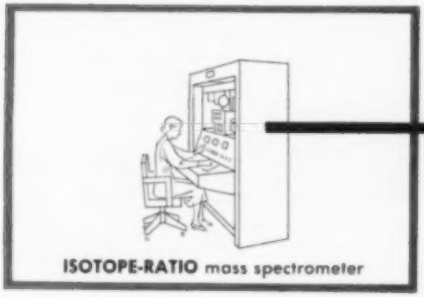
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VANNEVAR BUSH views . . .

**"Only too often the young man with a scientific background is more flexible under novel circumstances than is the young engineer, and this is much to be regretted."**

**"We ask a great deal of an engineer. We require that he understand science . . . be proficient in economics, in business . . . have a working knowledge of those branches of social science having to do with human reactions."**

**"There is a danger that the engineer will become set in a groove . . . much of his function will be taken over by the applied scientist."**

# Engineers—And Their Future

As we view the engineering profession today and what its position in our society may be in the years to come, I believe we can see certain trends that are bound to affect our affairs, and we may indeed be able to take some account of them as we plan.

There are some striking trends throughout the country in science, in engineering, and in industry.

Agriculture in its broadest sense is due for extraordinary changes. Science and engineering are entering into this phase of our civilization in far-reaching ways. The results of their application will be important in this country and still more important in the world as a whole, where the undernourished great populations are a persistent threat to our stability. Progress is becoming more apparent. For one thing there are the beginnings of cultivation in the sea, in the place of bare harvesting. In Scotland, fiords have been successfully fertilized, greatly increasing the yield of fish. This was done first by fortifying semi-enclosed bodies of water, thus producing rapid growth of plankton, seized upon by minnows and then by marketable fish, and it is being extended to more open waters. We are learning to raise oysters rapidly by control of nutrient micro-organisms. Our Department of Agriculture supplies plans which many farmers are now using for similarly developing stocks of bass in ponds, which have yielded as much as three hundred pounds per acre per year—a supply for a family. At the southern end of San Francisco Bay, where sea water is being evaporated for its salt, algae are being grown at one stage in the great basins, and copepods are then introduced to feed on the algae, and are harvested for protein.

There are new methods of reclaiming land, some of them quite novel. In Honduras, for example, the United Fruit Co. has been diverting a river to build up fertile soil. Through such diversion several feet of silt are laid down in a swamp. The river is diverted again, drainage canals are put in, and the result is beautiful, fertile land. In India and on the Rio Grande delta mechanical methods of removing weed growth and infestations have taken new form. The Indians used subsoil cutters to exterminate Kans grass, which has been taking over some ten million acres of wheat land. On the Rio Grande they use enormous plows that turn such big furrows that they bury alders and the like, and recover usable land in one step. We have seen in this country genuine progress resulting from contour plowing and erosion control.

But the new methods just around the corner appear to be far more important in the long run.

Take, for example, the development of chemical soil conditioners. These are not fertilizers, but they may be equally important in agriculture. They are chemicals which bond clay soils in a beneficial manner to give it good "tilth." Such chemicals occur naturally and are responsible for most of the benefit that results when organic matter is added to soil. But the natural chemicals obtained in this way are ephemeral, for they are soon attacked by soil bacteria. Now we are learning to use synthetic chemicals for the purpose, which are not thus attacked, and which give at least a semi-permanent improvement. Added to soil in small quantities—about a pound to the ton of soil—they facilitate water penetration and increase water-holding capacity. They allow air to enter for growth of aerobic micro-organisms and for root development. They improve root penetration, and allow seedlings to extend through the surface readily. They increase the availability of mineral nutrients and thus conserve fertilizer. With all other conditions unaltered, tests with them have resulted in from 20 per-

---

VANNEVAR BUSH is *President of the Carnegie Institution of Washington.* *This article is based on his remarks before the Joint Metropolitan Founder-Society meeting on the centennial of engineering, April 16, in New York.*

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If your filtration problem is unusual in any way, we will be glad to give you full engineering assistance. Sparkler filters are available in a complete range of types, sizes, and materials to fit every need. Write Mr. Eric Anderson for details.






cent to 80 per cent increase of crop under typical conditions. Here man has potentially a way of managing his soil that is capable of increasing the production of food very considerably indeed. This is a revolution in agriculture in the making, and no man can yet say how far it will extend. Much depends upon ultimate costs, but there seems to be no inherent reason why the new materials should be unduly expensive.

Another great change that may come is the production of foods by biological process industries rather than in the field. Carnegie Institution of Washington, for example, has been engaged in research on processes for the cultivation of algae as a source of proteins and oils. One method, which seems especially attractive, is to grow them in water circulated in plastic bags laid out along the ground. Under these conditions nutrient and carbon dioxide concentration may be controlled, and growth in full sunlight is rapid indeed. Moreover, by nutrient control, the nature of the product of these minute single-celled plants may be varied widely, from 56 per cent protein to 80 per cent fat, both in terms of dry weight. The subject is in its infancy, and it may for example appear that other algae than the one now being studied extensively will furnish an improvement. Exact costs are not known. Whatever the results of the present study may be, it is evident that some process, using some organism, is likely to furnish man with a source of foodstuffs obtained by operating a process rather than sowing a field, in enormous quantities with relatively little use of land, and apparently at a cost such that the status of whole populations may ultimately be greatly altered.

Man now makes rain. There is much controversy as to whether man is now able to alter climate in a region, but there is no doubt that he can cause a local cloud in proper condition to drop its moisture on the land, although if left to natural processes it would not do so. It takes little imagination to visualize the potentialities in such methods, the present ones or better ones later to be developed, if the initial promise is entirely fulfilled. But it will take more than imagination to control and apply the process with judgment and fairness to all.

We are, I believe, only at the beginning of what can be done with irrigation. When our source of stored fuels begins to decline we may turn to atomic energy for our power sources, but it is far more likely that we shall turn to energy from the sun.



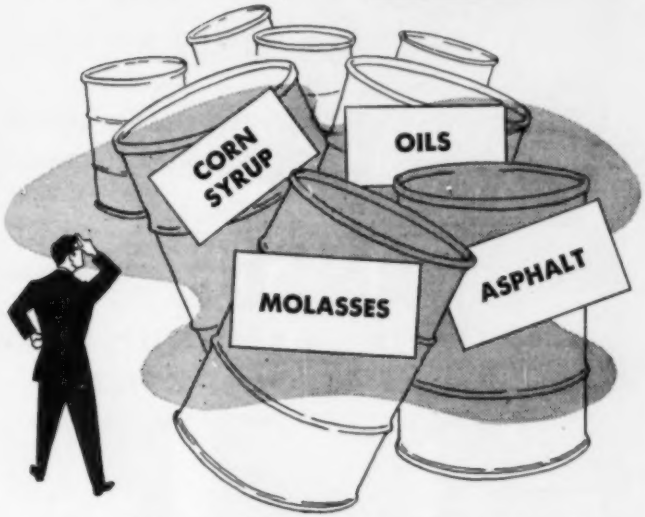
**"The engineer must understand science on the one hand and people on the other."**

Solar power for irrigation may be feasible even before our oil reserves begin to peter out.

Pest control is undoubtedly in its infancy; yet the potentialities, for example, of cattle raising in Africa, if the tsetse fly could be overcome, are enormous, and this control is only one phase of the entire matter. Insects mutate to escape insecticides. Flies get to like DDT, much as certain bacterial that we are able to produce have to have streptomycin to live. This means we must produce more and better insecticides and learn to use them so they do not knock out desirable insects—or the consumer.

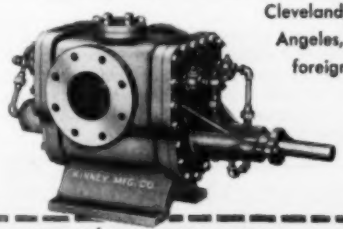
Animal and poultry husbandry are undergoing striking changes. Vitamin $B_{12}$, the growth vitamin, is now widely available. It has been found that common antibiotics, such as penicillin or streptomycin, produce unexpected effects. For some mysterious reason a combination of $B_{12}$ with antibiotics produces a result which is more than the sum of the individual effects. It gives an ability to utilize vegetable proteins in place of more expensive animal proteins. Rate of growth of chickens or hogs may be increased as much as 30 percent on the same weight of feed. Earlier maturity may be secured. Then, too, preventatives and cures are being found for some of the common diseases of animals and poultry, although it is true that new ones which are economically costly seem to continue to crop up or at least become identified. There is now a milk formula for small pigs,


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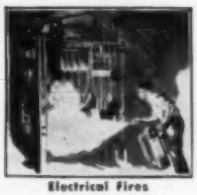
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which is said to reduce mortality greatly, and also to allow the sow to have three litters a year instead of two. We are learning to raise sheep that habitually give birth to twins. The introduction of Brahma crosses promises to revise methods of raising cattle in the South at least, and perhaps generally.

We shall not only have new methods of growing food, we shall have new methods of preservation and distribution. We have already witnessed what can happen when the handling of food in frozen conditions is exploited nationally, with deep freezes, locker systems, and the like. Frozen orange juice is probably not the last development along these lines. The process of sterilization by radiation without loss of vitamins or flavor is in its infancy, but it may go very far indeed. It may in time become the standard way of handling many food products that now are canned or frozen.

Agriculture in a way is only a part of the broad application of biology, and there are other aspects of biology that are on the verge of great improvements. In fact the biological sciences are to a cosiderable degree in the position occupied by the physical sciences some years ago. A gradually mounting fund of fundamental knowledge is moving to the point where a dam is about to break and release a flood of applications. Genetics, enzymology, biochemistry, and many other fields are going ahead at accelerated rates, and the day will arrive when there will flow from these and other biological branches many applications, not only in medicine, but in the whole field of the production of chemicals and the development and modification of materials.

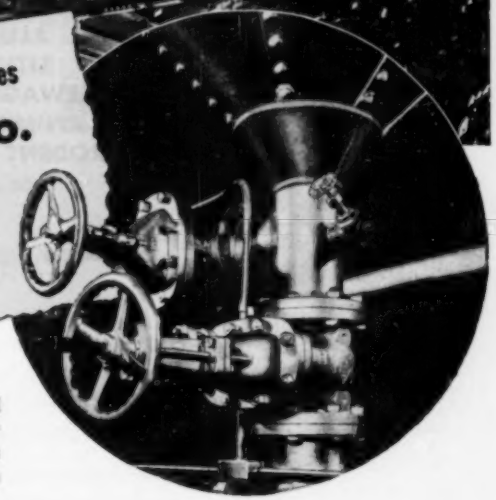
We have already seen important advances in the fermentation industries and in the production of antibiotics in the pharmaceutical industry. These advances have been accompanied by important syntheses, especially for medical use. In medicine, chemotherapy started with salvarsan, then flourished with the sulpha drugs, and then came the burst of antibiotics produced by microorganisms such as actinomycetes. Recently a new antitubercular agent, a fairly simple chemical long known, is taking us back to the earlier days of chemotherapy. Cortisone, a hormone produced in nature by the adrenal cortex, has been synthesized in the pharmaceutical industry from desoxycholic acid from beef bile, and can now be similarly produced starting with a sterol such as ergosterol. An exceedingly complex manufacturing process gives us a new



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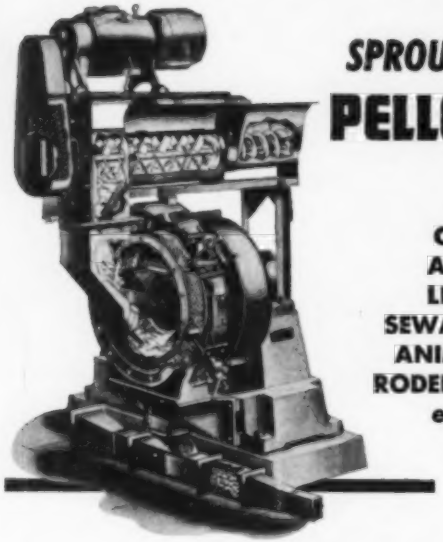
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and important addition to the physician's armory, and gives us an utterly new means of handling some of the worst scourges that affect mankind. Moreover, this may be the beginning of a whole new phase of medical practice. We have dealt with hormones for some time, notably with insulin in cases of diabetes. But the process of maintaining a normal hormonic balance as a means of preserving the health of the population generally may be the great medical accomplishment of the next decade. We are also beginning to understand viruses just a little bit, very little it is true in comparison with our present knowledge of bacteria; and the possibilities in this field, once we have overcome our ignorance, are far reaching indeed.

Some of the mechanisms of the human body are far better understood now than they were a while ago, although our ignorance is still vast. We are, for example, beginning to know something about the mechanism of muscle. Man can feel very humble when he studies muscle, for many ages ago nature accomplished something which man has never learned to do, namely, the transformation of chemical energy into mechanical work without the intermediary of another form of energy. Man can make a device such as a storage battery to transform chemical energy into electrical energy. He can construct a motor to turn electrical energy into mechanical energy. He uses both devices in his automobile. He can convert chemical energy into heat in his furnace, and heat in turn into mechanical energy through a steam engine. Or he can combine these two steps in the internal combustion engine. But he cannot go directly from chemical energy to mechanical energy by means he has yet evolved to any practically significant extent. Muscles can. Puzzled by his inability to emulate his own muscles, man wonders how this human system of his can develop all the work that it does on a little food without violating the second law of thermodynamics. He arrives at this predicament because he usually thinks of accomplishing this particular conversion of energy by the use of high temperature. The body doesn't do it that way. It makes the conversion directly. There is no mystery about it except perhaps the mystery as to why man has taken so long learning how to accomplish the same thing by use of one of the intricate devices of which he is often so proud. Perhaps some day man will learn to make and operate an artificial muscle. To this he will furnish fuel, catalysts, and control chemicals. He will activate it

**"Make engineers out of men from other fields."**

electrically, just as the electrical impulses in a nerve actuate a natural muscle. When he learns to do this he will enter a new era.

We are using chemical engineering tools of some sort at every point in our civilization. Fairly recently there has been an advance in methods which is especially significant. From the chromatographic separation of chemicals have been developed ion exchange columns. More flexibility has then been achieved by superposing an electric field on these, and then by carrying on the process of ion movement through a diaphragm. Here is an exceedingly important way of sorting things out. Nature usually mixes things up, although it did a lot of sorting when it separated ores in veins and gravel in beds. Man, in his use of natural resources, also mixes things up, and he may be sorry about some of his mixing activities before he gets through on this planet. Anything that sorts things, especially if it sorts selectively, may be very important. All the trend of ion exchange points in this direction. Ion exchange columns and diaphragms that will pass ions under control and thus purify water and separate chemicals will accomplish important results before very long. These chemical processes are probably capable of becoming highly selective so that we shall be able, for example, not only to make pure water from salt water, but, more important, to select from the great reservoir of the ocean the particular chemicals we desire without handling the entire mass. Another sorting mechanism which will bear watching is the use of chelating agents.

Today biology and chemistry are both advancing with great strides, and they are becoming more closely interlinked. The products of the alliance are going to become more widely used. The engineer when he enters the fields of applied biology and chemistry needs to be versatile indeed.

It is hard to visualize at the present time just where the matter of automatic controls in industry may be headed. We have had automatic substations in electrical engineering for a generation. Automatic telephone exchanges are now being extended to customer dialing of long-distance calls. Refineries have been so built that their operation is almost an automatic affair with very little manual supervision. Electronics is becoming more widely applied every day with the advent of such instrumentalization as the transistor. But the whole new art of electrical control systems has yet far to go. We can dream of automatic fac-

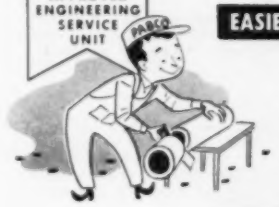

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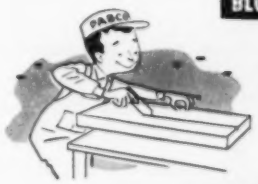
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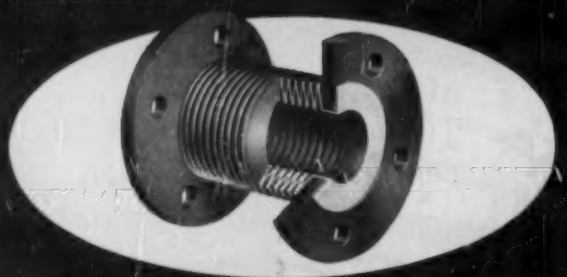
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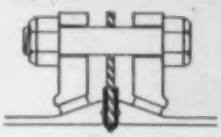
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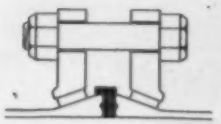


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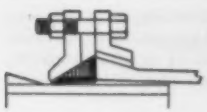


*(Above:)* **Chemiseal Expansion Joints, No. 212 for use where thermal expansion, vibration or misalignment requires a flexible pipe section. Sizes from 1 in. to 12 in. I.P.S.**

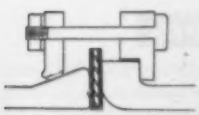
*(At left:)* **Chemiseal Jacketed Gaskets, Types T6N or T6-300, standard for Corning conical flanges, seal at low bolt loads.**



**Chemiseal Snap-on Type 820 Gaskets. Molded to match contour of conical-end glass pipe, they assure perfect automatic centering of joints and free flow of materials. Made for all standard pipe sizes from ¼ in. to 6 in.**



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**Chemiseal Adaptors No. 2-CRS, provide a tight, safe seal between glass coated steel or similar nozzles with large inside radii, and vessels of glass-lined steel, porcelain, Haveg, etc. Easy to handle, single units—these adaptors combine a steel bearing ring for rigidity, and a resilient core for perfect seal—both contained in a chemically inert Teflon Jacket.**

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tories and we do install automatic machines in many places; but our dreaming needs to be very practical indeed and hard-boiled, for there is no panacea here. In fact there is a multiplication of problems, for as we improve our handling of materials by the use of automatic devices, we require not less labor, but better labor, labor skilled in more diverse ways. We require, too, keen thought in order that the more abundant product made possible by a given amount of capital, labor, and management may be so attractive to the public that it will be readily absorbed in increasing quantites and render the whole economy more sound because of the technical changes that have occurred.

I should not leave this matter of giving examples without a bow at least to new materials. It is unnecessary to dwell at length on the succession of new fibers and new plastics or to expatiate upon new chemical substances such as the detergents. Neither do I need to review the extraordinary changes which are now occurring in metallurgy, with the advent of new materials there is also an important movement in the direction of new ways of handling old materials, of using taconite, for example, when our high-grade iron ores become expensive, or of employing advanced physical methods for surveys to find new sources of fuels and ores.

There is also a highly interesting present trend in instrumentation. In the field of making special instruments there are hundreds of new, small companies operating, making a profit, and making good. There is a cumulative effect when new powerful instruments are introduced, for facility at measurement itself produces new knowledge and new products. It was not so long ago that one found complicated instruments only in scientific laboratories and even there rarely. Today in industrial laboratories we find electron microscopes, tracer techniques, mass spectrographs, television techniques, ultra-violet methods for extending the capabilities of the microscope, and a host of other devices. Moreover, we find these used as tools in everyday exploration, and we find them manufactured in little, independent progressive manufacturing units all over this country. This situation is one of the most encouraging developments of the time. The real control of the tendency toward undue aggregation of business units, of the trend toward monopoly in the industrial field, lies in the continual advent of new, independent, healthy young industries. True we need effective administration of the anti-trust laws, in fact the pres-

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When De Laval machines, that remove impurities by centrifugal force, replace gravity or other less efficient methods of separation or clarification, they speed up the whole process by making it continuous. Doing work in a few seconds that otherwise would take minutes or hours, De Laval centrifugals remove the "point of interruption" on *your* flow chart. Often such a speedup results in an increase in production.

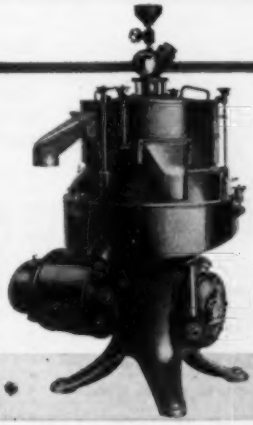
Each type of De Laval centrifugal is a highly specialized machine. Some are clarifiers that remove a solid impurity from a liquid. Some are separators that divide two liquids according to their respective specific gravities. Some separators both divide the liquids and continually discharge solids as well.

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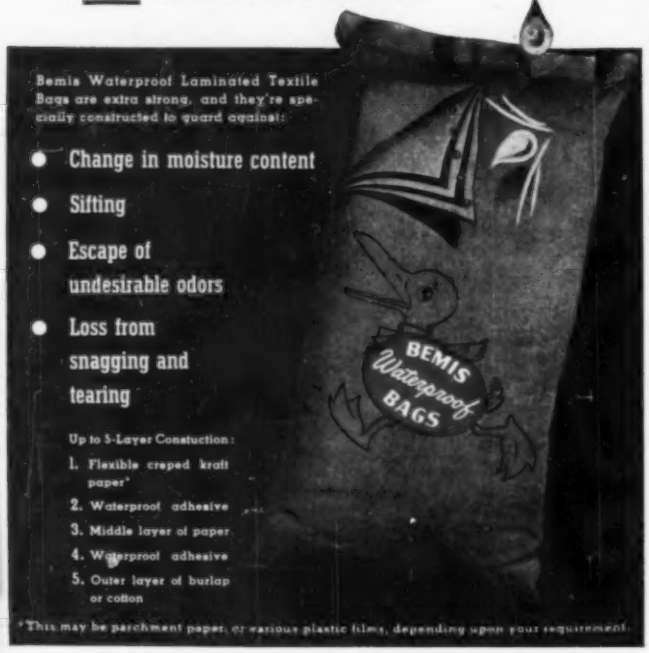
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ence of these laws has probably saved this country from very serious mistakes in the past. But the real influence that keeps our industry on its toes, truly competing, flexible in its approach, is the fact that it is still possible in this country to create and cause to prosper small industrial units which may sometime grow to real size. One of the commonest ways by which such units have become established in recent years has been through the development of new and useful instruments. If our industrial leaders are wise they will aid the trend in every way they can as these small outfits struggle to survive. And in connection with them there is an opportunity for engineers with courage and vision.

There is no doubt that the scene about is changing rapidly, and we could easily multiply examples and illustrations. But our question is what the engineer can do to maintain his rightful and useful place in the changing world that I have been describing. Certainly he must understand science on the one hand and people on the other. And he must know how to bring into one equation his knowledge of both in order that the cost of their functioning when they are brought into harmonious relation with each other may be less than the value of the social gain that results.

But no man can understand all of the sciences. Even scientists themselves cannot today read everything that is published currently in their own special fields. It is too much to ask, therefore, and it would be utterly unreasonable to ask, that an engineer understand science in all of its ramifications. The point is that he should be able in a few evenings to delve into any indicated corner of science that is nearing application, to understand what he finds there, to grasp the essence, to judge relative importance, and to avoid being misled. He will be able to do this only if versatility is part of his very nature, and such ingrained versatility must be acquired early during the period of his education. He also needs to be able to understand modern society and to work in it effectively. To do this is fully as difficult as to comprehend the scientific field, which he touches with the other hand.

The fields of knowledge which lie in the humanities and the social sciences are just as important to the engineer as the ones that lie in the physical and natural sciences. Here again the engineer can hardly be expected to understand all of economics, all of the social sciences, all of business methods. But if he has the right

sort of mind he can dip into these fields and understand what he explores. His understanding will depend in large measure on his ability to work well with men, inspire their confidence, and secure their respect. But here also he needs resourcefulness of mind and the courage of a pioneer.

It is said that there may be a great lack of engineers in the years ahead. I do not think this is necessarily true if the scope of our profession is enlarged in the manner I have suggested. Many of our greatest engineers in the past have come into the profession by unusual paths. There is no reason why we should not make engineers out of men from other fields if we need them, especially if they find among us a satisfying opportunity and they have the versatility needed for accomplishment under rapidly changing conditions. I think we can increase our number if we open up the unusual paths and if we regard the functioning of an engineer in a broader way than it is sometimes delineated. Certainly we are in changing times, and in order to encompass them and maintain the engineering profession in its proper sphere, we need to have a profession which can itself change and adapt.

Unfortunately in our engineering education and in industry for that matter, we have often in the past lost sight of the importance of breadth and adaptability in our engineers. In attempting to become general we have often in the past merely become superficial. We need to learn how we can develop among our young neophytes and in our profession generally those attributes which enable men to adapt themselves to change soundly, neither rushing blindly and without understanding into the novel path nor remaining in a groove which leads nowhere except into oblivion. —*End*

**MEMO FROM THE EDITOR**

(*Continued from page 145*)

Engineers we've shown it to say its a whiz for quick estimations of labor costs for new production units. You can also use it to gage whether your own plant is "up to par." All you have to do is to figure out how many "unit steps" you have.

Author H. E. Wessel, now with Midwest Research Institute, drew heavily on his own wide experience in industry in compiling his unusual "master" chart. Most of the plant data are based on actual figures.

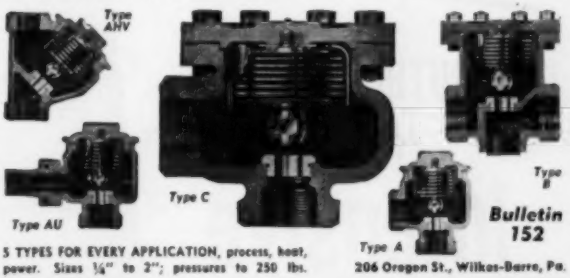
So, with a diet such as the samples I've just given, I hope this summer's weather and diversions won't trap you into "taking it easy" with your CE reading.

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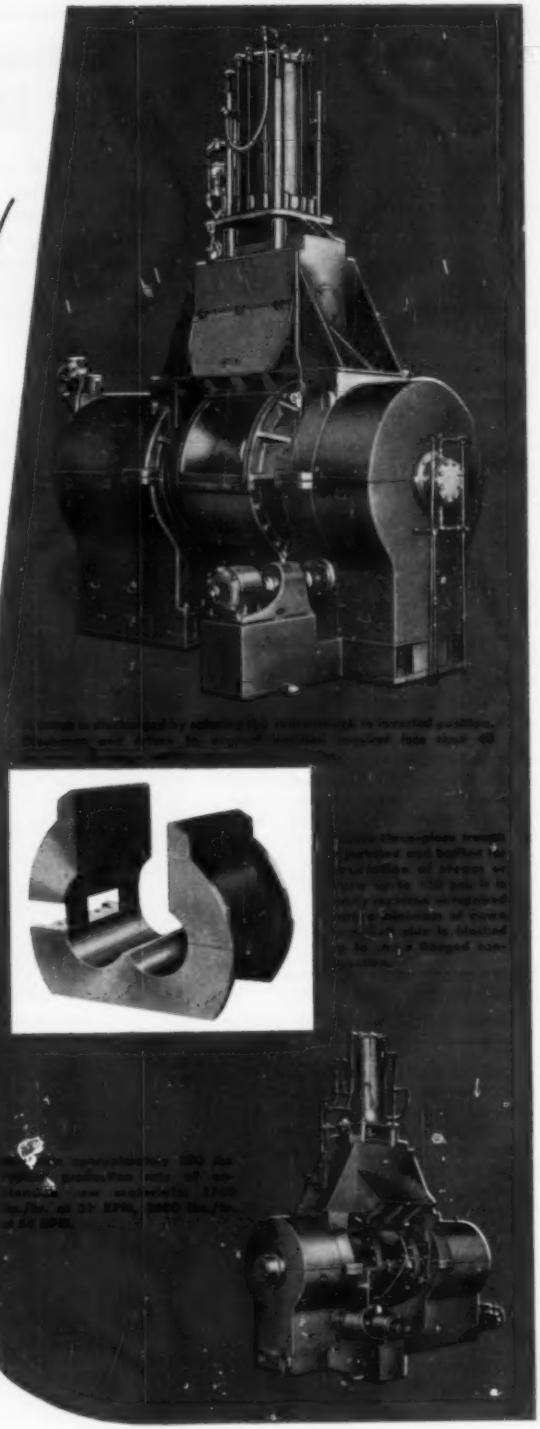
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# *Names in the News* Edited by Frances Arne



**MEN OF THE MONTH**

**E. S. Roberts and P. J. McGauley**

**Played key roles in working out Chemico's revolutionary new process for making metals—see p. 164 for process story.**

Last month we were tipped off by an alert member of our staff that it was time for our double bill—an unusual event in this department. American-Cyanamid-subsidiary Chemical Construction Co. planned to announce the revolutionary new process for cobalt refining on May 17. Principal developers: E. S. Roberts, Chemico vice president and chief engineer; Patrick J. McGauley, project engineer in charge of process development.

We duly telephoned Cyanamid's public relations man to arrange for an appointment with them.

We arrived for the interview in tandem with our photographer and a man from a sister McGraw-Hill publication. He was doing a story on the process. There were some technological loopholes he wanted filled in.

Vice president Roberts ushered our contingent into his office, pacing restlessly while we settled ourselves. He inserted a filter-tip cigarette in a holder. "This is the closest I can come to not smoking. I was beginning to get a morning cough." He showed us the variety of places the holder permitted him to lay down the lighted cigarette without danger of fire.

Mr. McGauley (the other member of the development team) arrived looking quiet and earnest. The public relations man arrived also looking earnest.

The first item on the agenda was picture taking. While the photographer tried to lure his subjects into some off-guard poses, the PR man drew us aside.

"Mr. Roberts," he said, "has some unusually diverse interests for an engineer. He likes the arts. He's fluent in three or four foreign languages.

"McGauley, I understand, is pretty wrapped up in his work. He's even got an office fixed up at home. One thing I can tell you about him from personal experience. He has a good clear way with the English language. He managed to get across to me the chemical theory behind this new process—and I'm no chemist. Uses a lot of colorful similes."

We turned to watch the progress of the cameras. Happily, Messrs. Roberts and McGauley were paying absolutely no attention to them. Mr. Roberts was intermittently writing on a piece of yellow paper and questioning his companion. When the flash bulbs stopped he rang for his secretary, handed her the yellow paper and told her to type it off and send it to such and such a restaurant.

He explained that he and McGauley had recently had lunch there and McGauley got more than he paid for: food poisoning. He had taken the opportunity to get the details straight and a written complaint filed.

Primed by our co-reporter, Mr. Roberts launched into the technical history of the new process. Abstracted and assured, he talked and gazed out the windows of his modern corner office. Occasionally he swung around to Mr. McGauley for corroboration or a specific detail.

We asked about the personal contribution of the two men to the development.

It seems that the basic idea came to Roberts years ago when he was working for an Italian company. A fluke result in one of his tests put him onto it.

He couldn't interest his company in investing in the idea's commercial development. When he came to Chemico in 1940 he met the same indifference.

In 1945 he became chief engineer; he decided to push the thing through, on a shoestring if necessary. Not being a metallurgist he set about hiring one.

McGauley interrupted, "You hired me mostly because of my experience with copper refining."

McGauley worked Roberts' idea up, expanded on its commercial possibilities to a point where the company had to be impressed. More men were put on the project. Right now three plants are being built on the basis of the results.

Here we asked the two men about their extracurricular interests, hoping to draw out Mr. Roberts, perhaps, on his artistic leanings.

But he smiled evasively. "Our only interest is chemical metallurgy." Mr. McGauley concurred.

"Where do you people live?" we asked.

Mr. Roberts answered that he lived in Manhattan, Mr. McGauley in Port Washington. We turned to the latter —"Do you do any gardening?"

He replied that his wife took care of that. "But," he added, with the air of a man who had a real accomplishment, "I commute on the Long Island Railroad."

We nodded rueful acknowledgement. We use the line ourselves, or is it vice versa.

---

**Sydney T. Ellis.** A vice president of Commercial Solvents Corp. Continues as assistant to the president. Chemical engineering graduate of VPI.

**Wallace B. Mathews.** Coordinator of of engineering and engineering research, manufacturing engineering department, Standard Oil Co. (Indiana). Formerly assistant chief engineer in the general office. Joined Standard in 1923. New assistant chief engineers: **Wilbur G. Guild** and **Ben Franklin.** New head engineer: **Robert R. Penman.**

**Morse G. Dial.** President, Union Carbide and Carbon Corp. Executive vice president since 1951. Joined the corporation in 1929. Cornell graduate. New vice president in charge of the company's alloys division: **Walter E. Remmers.** Joined Union Carbide in 1936. Has been

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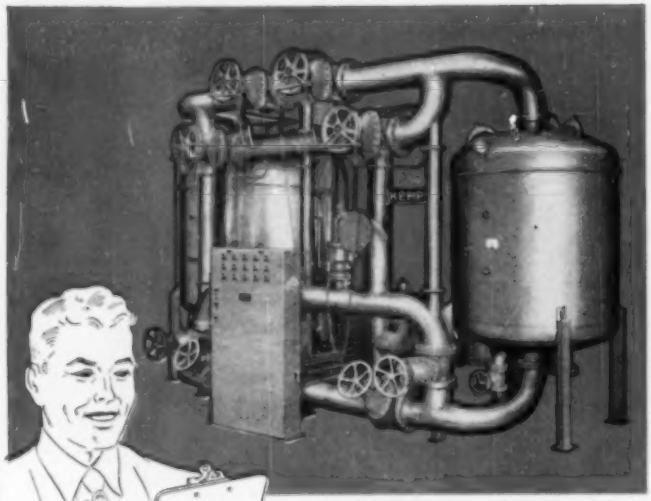
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NAMES IN THE NEWS, cont. . .

president of Electro Metallurgical Co. since 1948, president of the United States Vanadium Co. since 1950. Both companies are division of Union Carbide.

**Calvin S. Cronan.** Assistant editor, *Chemical Engineering*. Previously with Bird Machine Co. for four years as filtration engineer in charge of evaluation work on new equipment applications. Before that, with Dennison Mfg. Co. as a research and development engineer on paper products. Graduate of Northeastern University.



C. S. Cronan



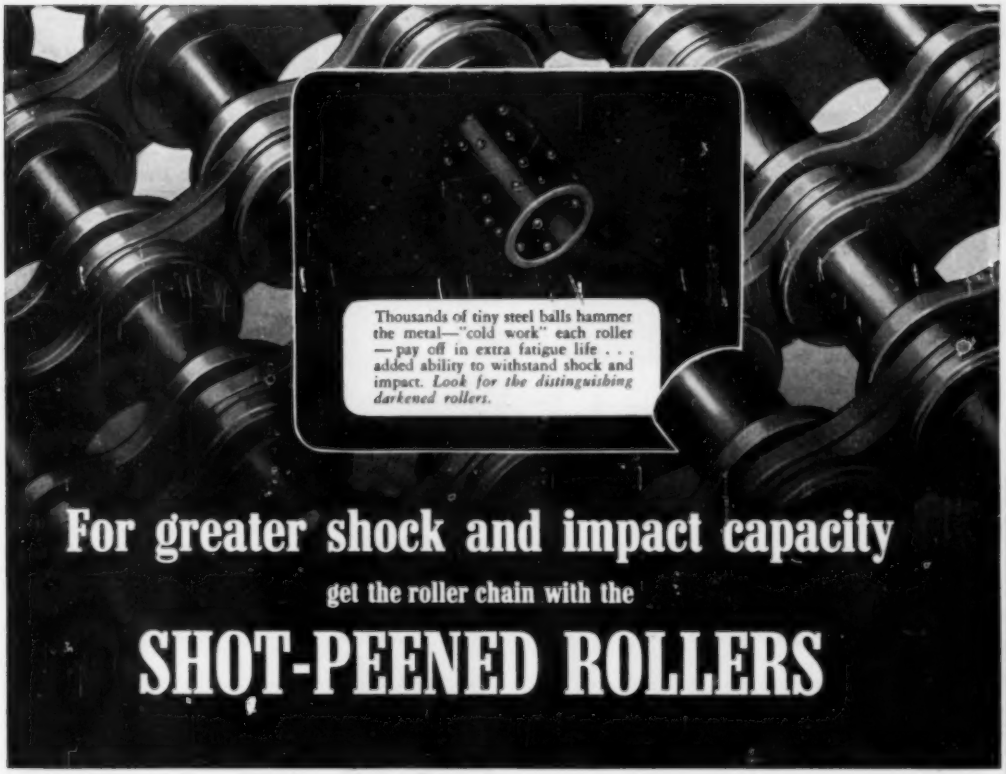
H. W. Zabel

**Herman W. Zabel.** Executive vice president of Roger Williams, Inc., engineering and economic consultants to the chemical and process industries. Has been director of research and development of Chemical Enterprises, Inc. Before that: engineering editor of *Chemical Industries*; later associate editor of *Chemical Week*. Previously associated with E. I. du Pont de Nemours & Co. and General Aniline & Film Corp. Graduate of Kansas State College and Columbia.

**Harold W. LeBoeuf.** From general foreman to production supervisor of GE's silicone plant at Waterford, N. Y. Joined the company's research laboratory at Schenectady in 1940. Chemical engineering graduate of Iowa State.

**Vadim C. Nedlutin.** Assistant manager of process development, Naugatuck Chemical Division, United States Rubber Co. New group leaders in the process development section: **Robert M. Greene** and **Robert L. Knapp.** Senior group leader for physical chemical research: **William F. Bruckseh, Jr.** Senior group leader for applied developmental research in synthetic rubber: **E. Leonard Borg.**

**Gordon M. Kline.** Recipient of the first annual Honor Award of the Washington Chapter of the American Institute of Chemists. Chief of the National Bureau of Standards




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organic and fibrous materials division. Since 1936, technical editor of *Modern Plastics* and editorial director of "Modern Plastics Encyclopedia." Joined the bureau in 1929. Studied at Colgate and George Washington University; doctorate in chemistry from the University of Maryland.

**Seymour C. Hyman.** Adjunct assistant professor of chemical engineering, New York University college of engineering. Also carries on a consulting practice and teaches at City College of New York. Has taught at Brooklyn Polytechnic Institute and Columbia. Chemical engineer, U. S. Army Signal Corps, 1942 to 1947; with Ashland Oil and Refining Co., 1940 to 1942. Studied chemical engineering at CCNY and VPI; doctorate from Columbia.

**Fred Olsen.** President of the Industrial Research Institute. Vice president for research and development, Olin Industries, Inc., East Alton, Ill. With the Olin organization since 1929. Known for his work in the development of stable nitrocellulose and in ball powder which is produced by and under water process.



F. Olsen



B. P. Martinez

**B. P. Martinez.** Chief of the Bureau of Mines' stream pollution research section for the Northeastern region at College Park, Md. Formerly process engineer for a steel firm at Sparrows Point, Md. Chemical engineering graduate of MIT.

**George V. Smith.** Adjunct assistant professor of chemical engineering, New York University college of engineering. Continues as research metallurgist, U. S. Steel Co. research laboratory. Previously taught at Brooklyn Polytechnic Institute. Doctorate from Carnegie Institute of Technology. Other new adjunct assistant professors of chemical engineering: **Fred D. Rose,** senior engineer, theoretical section, Sylvania Electric Products; **Arthur P. Weber,** technical director, International Engineering, Inc. Mr. Weber

was director of process development and process engineering, Kellex Corp., from 1944 to 1949.

**George V. Slottman.** Vice president, Air Reduction Co. Continues as the company's director of research and engineering, a post he has held since 1949. Joined Airco in 1934. Previously chief combustion engineer and iron works manager for the United Steel Cos., Ltd., Sheffield, England.



G. V. Slottman



W. Weinrich

**Whitney Weinrich.** Manager of the process engineering section of Catalytic Construction Co. of Philadelphia. Came to the company in 1950 to direct the process development for an uranium ore refinery under Catalytic's contract with the New York Operations Office of AEC. With Houdry Process Corp. from 1947 to 1950 as head of the chemical engineering section of its development division. Process engineer with the Petroleum Administration for War then joined Phillips Petroleum Co. in pilot plant section of its che engineering division. Befor Gulf Research and Dev opment Co. for 10 years in research and development, pilot plant operation, process design and economic studied. Graduate of MIT.

**Eric P. Tuennermann.** Production superintendent, Dow Chemical Co.'s new polystyrene plant at Allyn's Point, Conn. Formerly a member of the plastics planning and engineering department. With Dow since 1931. Chemical engineering graduate of Case Institute of Technology.

**Irving C. Matthews.** Retired as head of the chemistry division of Kodak research laboratories, Eastman Kodak Co. Joined the company in 1918 as head of applied chemical work for its Rochester divisions. Graduate of Syracuse University.

**Thomas K. Sherwood.** To devote his full time to teaching and research in chemical engineering at MIT. His successor as dean of the institution's school of engineering: Ed-


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—Steam tube dryer for materials that must be dried by indirect heat and at low temperatures, such as chemicals, grains, food products.

CLASS XF
—For direct heat drying at temperatures above 212°. A single shell counter-flow dryer that does not discharge the material through the furnace.

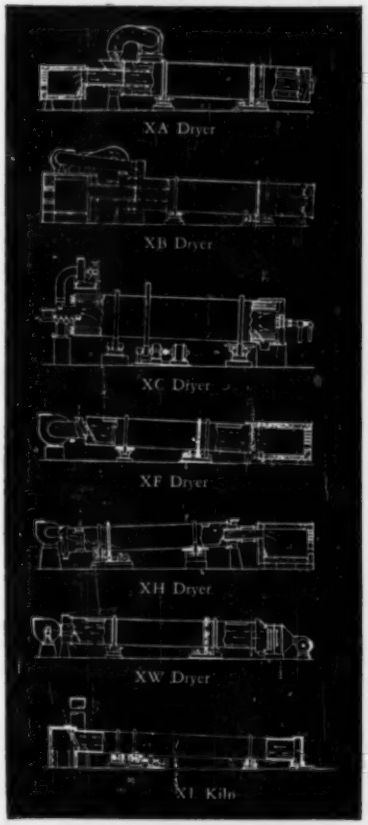
CLASS XH
—For direct heat drying at temperatures above 212°. A single shell parallel flow dryer designed to handle sticky materials.

CLASS XW
—For material that can be dried by hot air at temperatures below 212°. Dries ammonium nitrate, potassium chloride, etc.

KILNS
—Rotary type for drying, calcining, roasting or oxidizing at temperatures above the range of ordinary dryers. Refractory lined.

COOLERS
—Air, water spray or submerged rotary type. Each designed for the efficient cooling of materials from kilns or roasters.

*Bulletin 16-D-11 describes entire Ruggles-Coles line.*



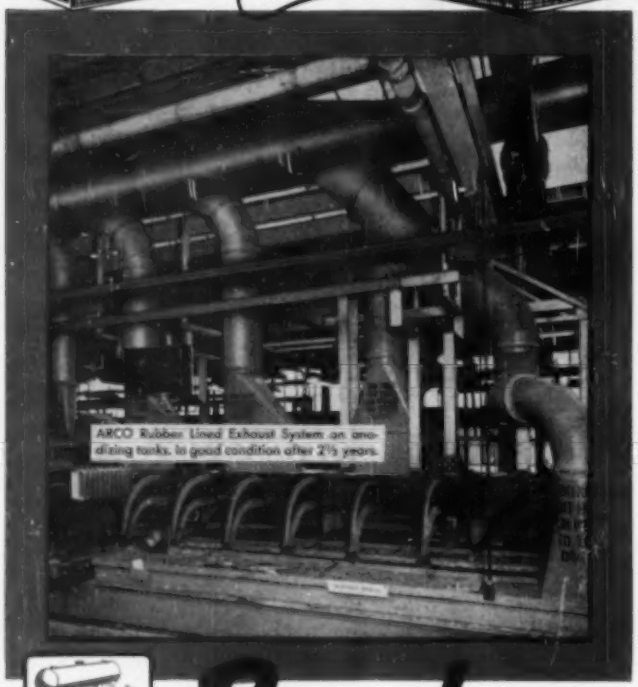

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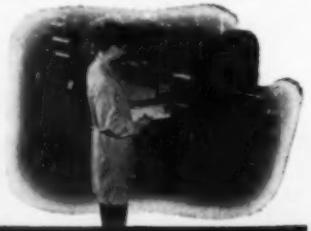





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**ward L. Cochrane,** head of MIT's department of naval architecture and marine engineering.

**Norman S. Haas.** Administration and operations manager of the chemical products section, Atlantic Refining Co. Has been sales correspondent in that section since 1948. Joined Atlantic in 1946 as a member of the product control department.



N. S. Haas



H. L. Cox

**Henry L. Cox.** Vice president in charge of the chemical division, Corn Products Refining Co., Argo, Ill. Joined the company in 1944. Doctorate from the University of Chicago.

**Paul L. Kartzke.** Vice president and area manager in charge of exploration and production for Shell Oil Co. of Canada in western Canada. Formerly Rocky Mountain division manager in charge of operations in Williston Basin.

**John Guthrie.** Plant manager of Alaska Pine & Cellulose Ltd. mill at Woodfibre, B. C. Chemical engineering graduate of the University of British Columbia.

**Robert H. Rogge.** Assistant director of engineering in charge of pilot plant and development work in the chemical division of Corn Products Refining Co., Argo, Ill.

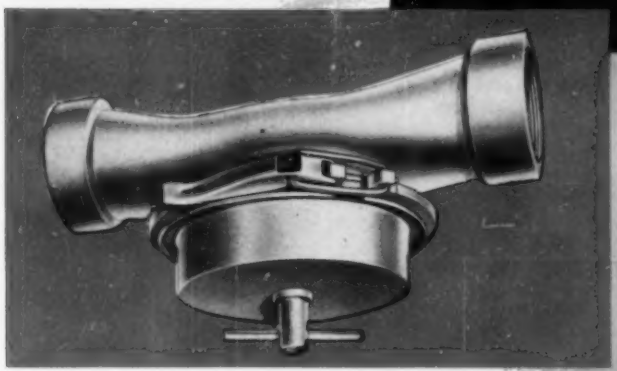
**Vincent C. Henrich.** Vice president, Rohm & Haas. Continues as manager of the company's plant in Houston, Tex. Joined the company in 1922 as a chemist at the company's plant in Bristol, Pa. where he was made production superintendent in 1939. In 1942, manager of the company's Knoxville, Tenn., plastics; assumed his present duties in 1948.

**Charles M. Switzer.** Retired as director of the nylon manufacturing division, Du Pont's textile fibers department. Started with Du Pont in 1915 as a chemist at the Carney's Point, N. J., plant. Graduate of Washington and Lee University.

# STOP PRODUCT CONTAMINATION

with TRI-CLOVER MAGNETIC *FULL-FLOW* TRAPS





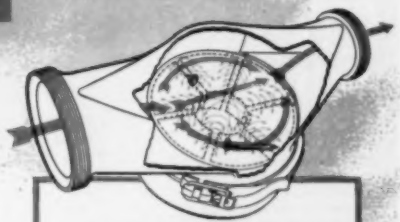
● **Above: Tri-Clover *ALL-SANITARY* Full-Flow Magnetic Trap, with highly polished finish inside and out, and Acme sanitary threaded ends. Available in 2", 3" and 4" O.D. sizes.**

● ***Left:* Tri-Clover *INDUSTRIAL* Type Magnetic Full-Flow Trap, with pickled finish. Available with I.P.S. screwed ends, or with Van Stone ends for every application, in 2", 3" and 4" sizes.**

TRI-CLOVER Magnetic Full-Flow Traps are now available in both Sanitary (polished finish, with Acme Threads) and Industrial (pickled finish, I.P.S. threaded or flanged) construction in 2", 3" and 4" sizes. Both types are fabricated from type 304 Austenitic stainless steel, and offer maximum corrosion-resistance, streamlined flow, with minimum product agitation and friction.

With an extremely wide magnetic contact area, plus the use of the strongest magnet known, you can now eliminate the hazard of tramp iron in your liquid conveying lines, which can contaminate your product and damage your machinery.

Over 30 years of specialized experience in supplying the food, dairy and chemical industries with corrosion-resistant fittings, valves, pumps and tubing has been utilized in this newest development of Tri-Clover. For further details, write for your copy of CATALOG SHEET 1151.



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**The arrows above illustrate how fluid, upon reaching the Tri-Clover Magnetic Trap, flows in a widening stream over the magnetic field. Tramp iron is trapped in a recessed area over the extra-wide magnet area, and is easily removed by simply releasing ring clamp. No need to remove entire magnetic trap from the line.**

***READY FOR CLEANING IN JUST 2 SECONDS***

*. . . It's just this simple. Unsnap ring clamp. Clamp, magnet and gasket are freed and ready to clean. That's all there is to it!*

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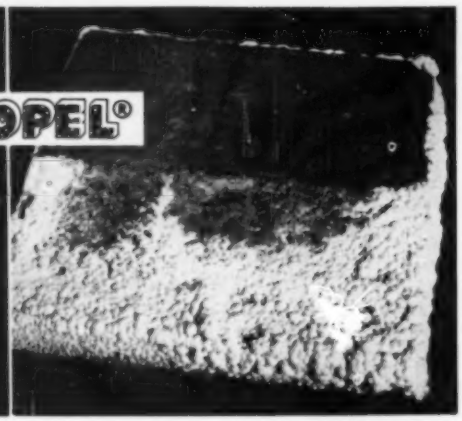
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The HYDROPEL (top half) part of this block absorbed little of the salt solution in which it was placed until all had evaporated. Air entrained concrete (lower half) sucked up the solution, leaving salt crystals throughout.



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Oakland 1, Calif. Portland 7, Ore.
Washington 6, D. C. San Juan 23, P. R.

NAMES IN THE NEWS, cont. . .

His successor in the nylon division: **George E. McClellan,** formerly director of the rayon manufacturing division. Mr. McClellan's successor: **W. Sam Carpenter,** formerly director of the acetate manufacturing division. Mr. Carpenter's successor: **William L. Scarborough,** formerly manager of the acetate production section. From manager of the company's Spruance rayon plant, Richmond, Va., to manager of the acetate production section: **Thomas Taylor.** From manager of the Yerkes rayon plant to manager of the Spruance plant: **Rollin F. Conaway.** To succeed Mr. Conaway: **Edward M. Cooper,** manufacturing superintendent of the Old Hickory, Tenn., rayon plant.

**Richard W. KixMiller.** General manager, chemical division, Celanese Corp. of America. For the past year, assistant general manager of the division. Joined the company in 1946. During World War II, with the Navy as assistant manager of reasearch and development, Rubber Reserve Co.



R. W. KixMiller

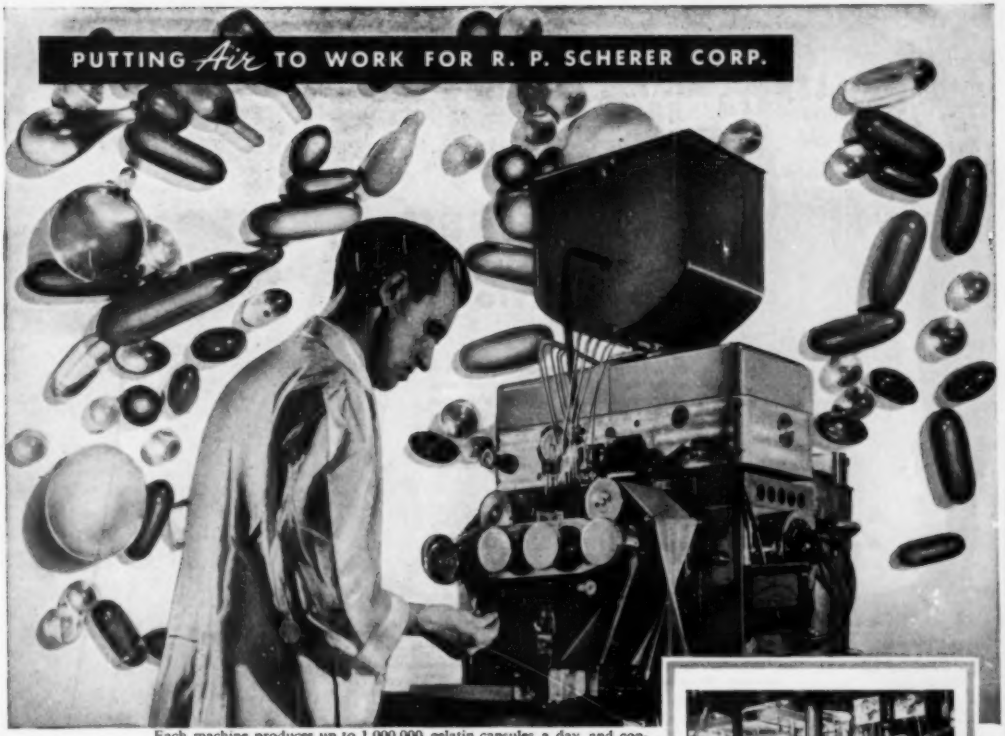


G. E. Scofield

**George E. Scofield.** Assistant resident manager, Fernandina Division, Rayonier, Inc. Formerly chief chemist. Joined Rayonier's Gray Harbor Division laboratory staff in 1937. Chemical engineering graduate of the University of Washington.

**E. M. James.** President of the American Oil Chemists' Society for 1952-53. Technical adviser to the board of Lever Bros. Co., New York. New vice president of the society: **Procter Thomson,** associate director in charge of process standards, chemical division, Proctor and Gamble Co., Cincinnati. Secretary: **T. H. Hopper,** head of the analytical and physical division, Southern Regional Research Laboratory. Treasurer: **J. J. Vollertsen,** retired chief of chemical research development, Armour and Co., Chicago.

**James G. Knudsen.** Assistant professor of chemical and metallurgical engineering, college of engineering,




Each machine produces up to 1,000,000 gelatin capsules a day, and controlled atmosphere is a "must" to assure dependable production schedules.

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Capsules . . . capsules . . . capsules—name your size, shape and color! They turn out millions a day filled with anything from vitamins and medicine to lighter fluid and insecticide here at R. P. Scherer Corp. in Detroit. But watch out for moisture-laden air. Until they're dried, these soft gelatin containers are regular little water magnets.

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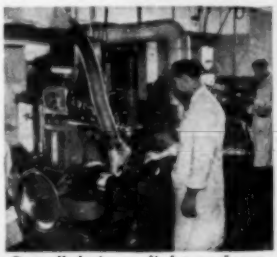
**The result?** For nine years their Westinghouse system has operated continuously without a single shutdown caused by mechanical failure. This full-time service equals *forty years* of normal service on an equivalent comfort air conditioning system.

Whatever your process involves in the way of a controlled climate, we can help you *put air to work* with air conditioning, air cleaning and air handling equipment. Call the Westinghouse Air Conditioning Distributor listed in the Yellow Pages, or write to Westinghouse Electric Corp., Air Conditioning Division, Hyde Park, Boston 36, Mass.

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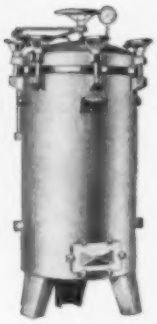
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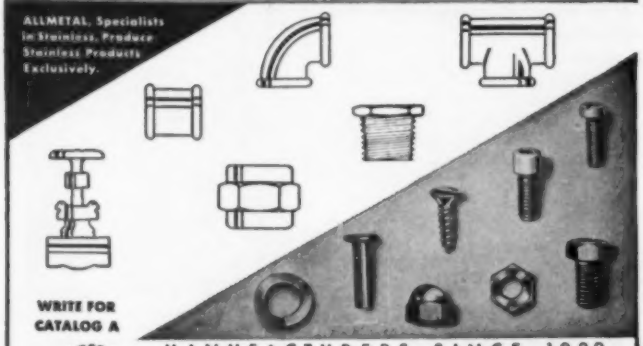
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University of Michigan. Formerly associate professor of chemical engineering at Oregon State College. Doctorate in chemical engineering at the University of Michigan.

**Lawrence W. Strattner.** From deputy administrator to assistant administrator heading the chemical, rubber and forest products bureau, NPA. On leave as administrative vice president of the West Virginia Pulp and Paper Co., New York. With the company since 1916. Graduate of the University of Dayton.



L. W. Strattner



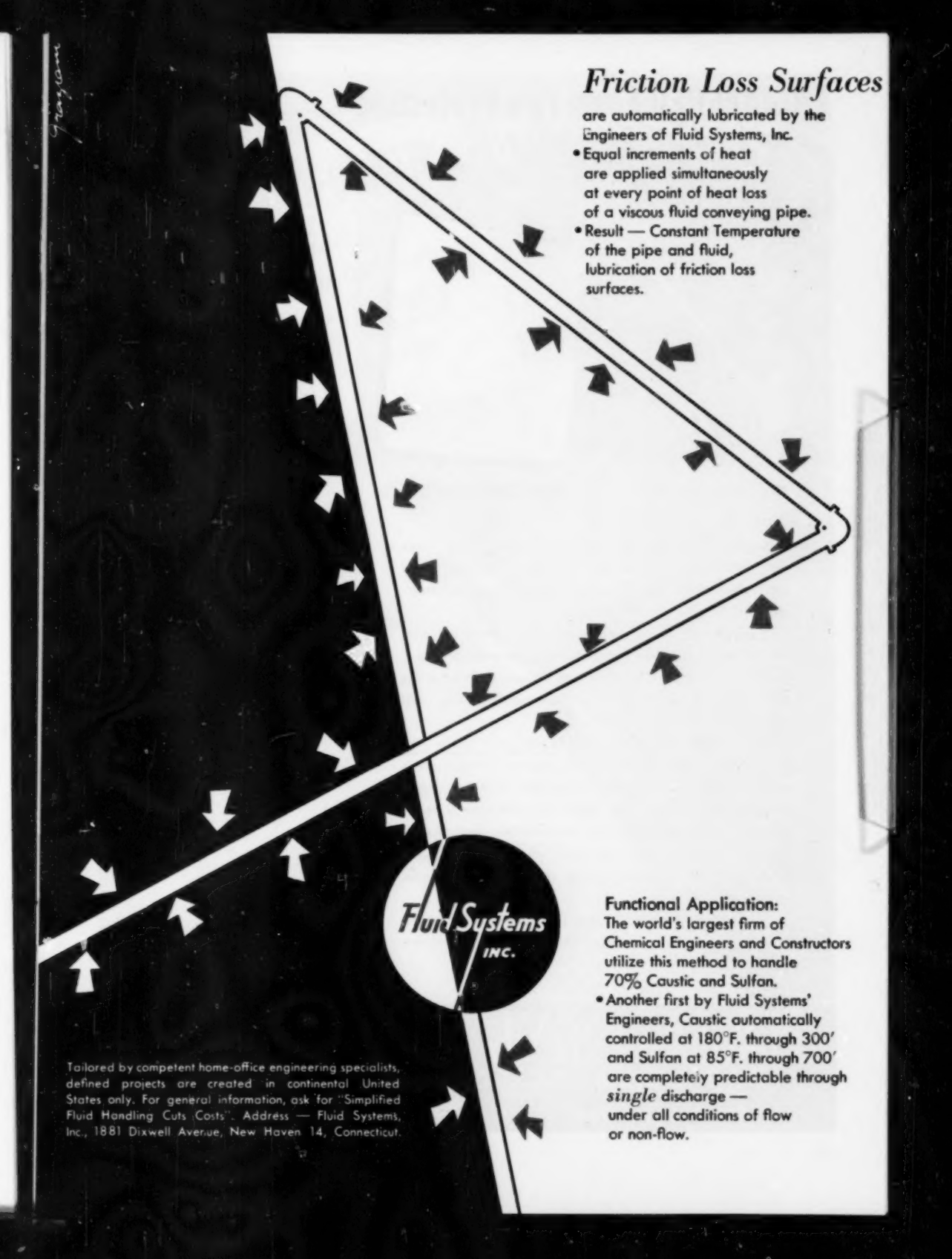
G. T. Collins

**George T. Collins.** From manager of market research to assistant to the president of Pennsylvania Salt Mfg. Co. Joined the company's market research department in 1943. Previously with the Barrett Division of Allied Chemical and Dye Corp., first as a chemical engineer in pilot plant work and later as a research group leader in sales development. Chemical engineering graduate of Villanova College.

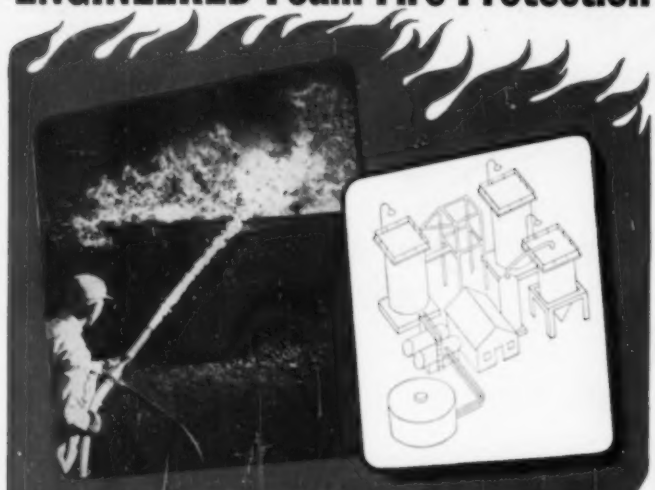
**Nolan B. Sommer.** Supervisor of the new product development department, American Cyanamid. Previously market development manager for Jefferson Chemical Co. From 1944 to 1947, research chemist in Cyanamid's Stamford, Conn., research laboratories. Doctorate from Indiana University.

**Sidney D. Kirkpatrick.** Elected to honorary membership in the American Institute of Chemists in recognition of his contributions to the professions of chemistry and chemical engineering. Editorial director, *Chemical Engineering* and *Chemical Week*.

**Milton Greene, Daniel Livingston** and **Leon Rubin.** New research scientists in the photographic laboratories, Polaroid Corp., Cambridge, Mass. Mr. Greene: formerly a research chemist at the Wyeth Institute in Philadelphia and at the laboratories of Hoffmann-LaRoche Inc., Nutley, N. J. Mr. Livingston: formerly di-


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rector of research at General Latex and Chemical Co., Cambridge, Mass. Mr. Rubin: formerly a research associate on the faculty at Columbia.

**Dominic Danna.** Assistant chief engineer, Monsanto's Western Division. Formerly general operating supervisor of the company's John F. Queeny plant in St. Louis. Joined Monsanto as a chemist in 1941. Graduate of Georgia Tech.

**Ernest Levens.** Head of the new organic section of the research department of American Potash & Chemical Corp. Formerly director of organic research and development, Frederick S. Bacon Laboratories, Watertown Mass.

**Edward Tarnell.** Market research analyst of the consulting firm of Roger Williams, Inc., which specializes in chemical engineering economics and market research. Formerly with the research department of Koppers Co. and with the National Magnesia Co.

**W. V. Cropper.** Assistant chief chemist, Standard Oil Co. (Indiana) research laboratories at Whiting, Ind. Since 1946, group leader at the company's Casper, Wyo., laboratory. Joined Standard in 1942. Graduate of the University of Kentucky and Kentucky Wesleyan college.

**A. T. Look.** From coordinator of raw materials and plastics production to superintendent of vinyl chloride and saran plasticizers, Dow Chemical Co. Joined Dow in 1946 as head of the extrusion molding section of plastics technical service. Graduate of Colorado University. His successor as coordinator: **Kenneth G. Harding,** a member of the company's product engineering department for nine years.

**Henry E. Craven, Jr.** Manager of the newly organized Lake Charles Division of the Davison Chemical Corp. With Davison since 1951. Previously plant manager for Pemco Corp., Baltimore.

**Robert D. Carpenter.** Research chemist, research and development division, Commercial Solvents Corp. at Terre Haute, Ind. Iowa State graduate.

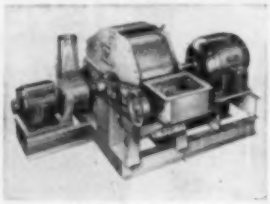
**J. G. Affleck.** New member of the new product development department, American Cyanamid Co. Formerly


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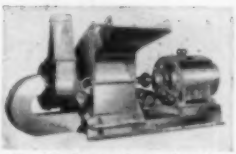
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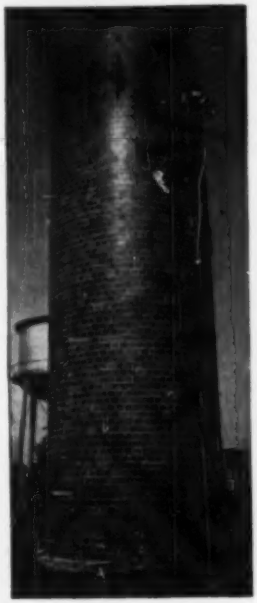


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with the company's Stamford research laboratories engaged in process development work. Princeton graduate.

**Robert P. Parker.** Director of chemical research, American Cyanamid's Calco Chemical Division. Joined Calco's research department in 1934; group leader, 1938; sectional director in the organic research section, 1944; assistant to the director of research, 1946; assistant director of research of the pharmaceutical section, 1947. Doctorate from Yale. His successor in the pharmaceutical section: **J. J. Denton,** formerly a sectional director in the section.

**F. L. Byrom.** Production manager, tar products division, Koppers Co. Formerly superintendent of the division's Follansbee, W. Va., plant. His successor at the Follansbee plant: F. M. Smith, formerly assistant superintendent.

**Paul M. Gross.** Recipient of the first honorary award of the Florida section of ACS in recognition of his outstanding achievements in the field of chemistry. Vice president of Duke University. President of the Oak Ridge Institute of Nuclear Studies.

**Roger E. Hatton** and **William S. Knowles.** Group leader in the research department of Monsanto's organic chemicals division. Mr. Hatton joined the company as a research chemist in 1945. Doctorate from Purdue. Mr. Knowles joined the company in 1942. Doctorate from Columbia.

**Louis D. Croce.** Project group leader, Evans Research and Development Corp., New York. Doctorate from NYU.

## OBITUARIES

**George Lee Lindsay,** 55, director of tests and research, Universal Atlas Cement Co., died in New York on April 24. Joined the company in 1925 as a chemist. Graduate in chemical engineering from the University of Minnesota.

**John S. Shaw,** 67, former director of safety of Hercules Powder Co., died in Houston on April 26. Joined Hercules in 1913 as superintendent of acid and high explosives production in Hercules, Calif. He had been director of safety since 1941. Studied chemistry at Michigan State College and Johns Hopkins.

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**IRONING COMFORT INTO SHOES** is done with Compo's "Lining Smoother" — a heated metal form which is placed inside a shoe and spread open, to smooth wrinkles out of the lining. For the precise temperature control needed to avoid scorching with too high heat, or inadequate ironing with too low heat, a Fenwal THERMOSWITCH unit provided the ideal solution.



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**SEND FOR THIS NEW CATALOG** for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal, Incorporated, Temperature Control Engineers, 166 Pleasant Street, Ashland, Mass.

Fenwal

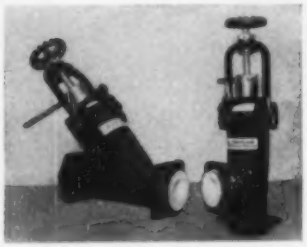
**THERMOSWITCH®**

**Electric Temperature Control and Detection Devices**

**SENSITIVE . . . *but only to heat***

# INDUSTRIAL NOTES

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**Lapp Insulator Co.,** Le Roy, N. Y.—Y and angle valves of solid chemical porcelain armored with fiberglass reinforced plastic. Piping and other equipment is also now available in the same material.

**American Pulley Co.,** Philadelphia—Magnesium appliance handling equipment. These products were previously made by Keen Mfg. Co., Harlington, Tex., which was recently purchased by American Pulley.

**Oscar Fisher Co.,** Peekskill, N. Y.—Temperature control and liquid refrigeration units, water filters, heatless drying cabinets. The company will also fabricate stainless steel tanks, vats and sinks, laboratory furniture and other equipment from laboratory size to full production capacity for the chemical and dye processing industry.

## NEW FACILITIES

**International Minerals and Chemical Corp.,** Potash Division—A $2.5 million plant at Carlsbad, N. M., to produce magnesium oxide and hydrochloric acid from waste liquid used in processing potassium sulphate. Although New Mexico is well supplied with fluorspar, coal, petroleum, natural gas and potash, this will be the first large plant to be devoted exclusively to chemical production.

**Monsanto Canada Ltd.**—The facilities of Barringham Rubber and Plastics Co., Oakville, Ont., which it has purchased. The Barringham company, to be operated as a Monsanto subsidiary, manufactures vinyl chloride plastic, a wide range of plastic-coated fabrics and rubber products.

**Jefferson Chemical Co.,** New York—A new process unit to produce lubricating oil additives at its Port Neches, Tex., plant. Construction will begin before the end of the year. The company also expects to make a major addition to its present laboratory buildings at Austin, Tex.

**Reichhold Chemicals, Inc.**—A technical service laboratory and offices for management, sales and office personnel at the company's Midwest Division plant at Summit, Ill.

**Great Northern Paper Co.**—A $6 million kraft mill to be built near Moosehead, Me.

**Fischer and Associates,** Cleveland—New offices at 5209 Euclid Ave. A consulting engineering firm, it is headed by Hans F. Fischer.

**Quaker Rubber Corp.**—A new branch office and warehouse at Kearney, N. J., for sale of its conveyor and transmission belting, industrial and fire hose, sheet packing, molded products.

**Procter & Gamble Co.**—A $25 million soap plant in Sacramento, Calif. It will be completed by the end of the year. NPA recently announced allotment of materials totaling over $12 million for the project.

**O. Hommel Co.**—An office, warehouse and laboratory in Los Angeles. A complete stock of ceramic colors, pottery and porcelain enamel frits and chemicals will be stocked.

**Permanente Cement Co.** — A 7,000 bbl. bulk delivery plant at Kodiak, Alaska, to be opened June 1. New plant, the company's third in Alaska, will receive bulk cement by barge from Permanente's Seattle distribution plant.

**Pacific Portland Cement Co.**—A $3 million cement works at Grants Pass, Ore., approved by DPA.

**Flexible Package Co.,** Chicago—A five-story building adjoining its current plant doubles production capacity.

**John Powell & Co.,** New York—A Paris office, headquarters of its overseas affiliate, John Powell International, Inc. The location will enable Powell to better service European agricultural and household insecticide needs.

**Dow Chemical Co.**—A $3 million plastics plant at Torrance, Calif., for production of styron. A 56-acre site has been purchased and government approval has been received. A second plant is also in the planning stage. It would produce styrene latex and may be located at Pittsburg, Calif.

**A. E. Staley Mfg. Co.,** Decatur, Ill.—Sales offices at Cleveland and Philadelphia to promote sale and distribution of the company's package and industrial starches, sirups, dextrins, glutamate and special products.

**Monsanto Canada Ltd.**—A $100,000 laboratory and office building at Vancouver, B. C. The new facilities will be adjacent to existing plant at Marpole and represent the third major project by Monsanto in the Vancouver area in the last four years.

**Hewitt-Robins, Inc.,** Stamford, Conn.—A Kansas City, Mo., branch office to handle sales in that area of its conveying and vibrating machinery and such industrial rubber products as hose and belting.

**United States Rubber Co.**—A plant in Stoughton, Wis., for production of lightweight, unsupported and supported plastic films.

## NEW LOCATIONS

**Commercial Solvents Corp.** has moved its offices to 260 Madison Ave., New York, N. Y.

**U. S. Industrial Chemicals Co.** has moved its head office to 120 Broadway, New York, N. Y.

**General Aniline & Film Corp.,** New York, has moved the product development department of its General Aniline Works Division to 435 Hudson St., New York, N. Y.

## NEW COMPANIES

**Quelcor, Inc.,** Chester, Pa., to coat, mold and produce polyvinyl chloride paste resins and to offer consultation and engineering service to chemical and allied industries. Heading the new company is J. Watson Pedlow, formerly assistant director of American Viscose Corp.'s mechanical development department.

# GET

"PIN POINT CONTROL"

WITH

# HANCOCK

## FLOCONTROL VALVES

Say "good-bye forever" to filed notches, paint daubs, string tying and other makeshift ways of marking globe valve settings. With Hancock Flocontrol Valves in your lines, you can be sure of "pin point control" of flow, temperature or pressure. The sturdy micrometer dial and pointer attached to the bonnet permits settings to within a 1/100th turn of the handwheel! And, you can instantly duplicate any setting exactly, any time.

Hancock Flocontrol Valves are available in bronze and steel. Both types are strong, leak-defying valves with scientifically designed V-Port disc that *compels proportional flow throughout the entire lift of the valve stem.* Because these valves have long-wearing Acme threads, straight-line flow is not dependent on the short-wearing, fine threads of a needle valve. The seats and discs are superfinished "500 Brinell" stainless steel. Foreign substances or steam cutting effects are minimized.

Eliminate guesswork. Minimize repairs and maintenance. Install the most efficient and economical valves you can use — Hancock Flocontrol Valves. Get in touch with your nearby Hancock Distributor for complete information.




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**When Hancocks go in, valve costs go down**

# HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** WATERTOWN 72, MASSACHUSETTS

MAKERS OF 'HANCOCK' VALVES, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

# New corrosion-resistant fittings

# reduce assembly time

## reduce piping costs, too!





**Speedline aligning connector**

*Joins pipe schedules 5, 10 and 40. Also made for use with tubing.*



**Speedline insert flange**

*Corrosion-resistant serrated insert in a carbon steel flange. Only tools needed for assembly are a standard expander and open-end wrench.*

**Speedline tube union**

*Combines best features of screwed pipe and sanitary unions; eliminates leakage encountered with ground joint type fittings.*

• Fast, low-cost installation of light-wall, corrosion-resistant lines is now possible with *Speedline* Fittings. Exclusive design of flange, for example, eliminates need for welding or flaring. Joints are tight and leakproof . . . a big improvement over other types of fittings.

The cost of *Speedline* Fittings is surprisingly low. And because you can use light weight Schedule 5 pipe or tubing, your piping costs are reduced by as much as 40%. As one engineer says: "We started to use *Speedline* Fittings with Schedule 5 pipe to save money. Now we find that we also get better flow conditions and increased capacity in our lines."

To learn more about this way to improve process piping layouts—at a lower cost than you have been paying, ask for a copy of the *Speedline* Fittings book.

**Book Shows How to Save Money —Even Under Today's Conditions**

Just write a note on your company letterhead and we will mail the *Speedline* book to you. It shows *why* you get better results at less cost with *Speedline* Fittings.

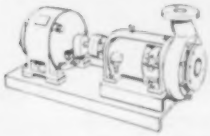


**Speedline Corrosion-Resistant FITTINGS**

*—the newest thing in pipeline economy*

**HORACE T. POTTS CO.** *Since 1815* Erie Avenue & D Street • Philadelphia 34, Pa.

THREE REASONS WHY THEY'LL GIVE YOU BETTER SERVICE . . .



# ❶ I-R Chemical Pumps are Armored against Corrosion with IRCAMET

These Ingersoll-Rand chemical pumps are built to stand up under the continuous handling of corrosive and abrasive liquids. All parts of the pump that come in contact with the liquid are made of IRCAMET — a high nickel-chromium-molybdenum alloy steel developed exclusively by I-R for chemical pump service. Laboratory tests and years of field experience have proved its exceptional ability to resist the corrosive action of a wide variety of acids and alkalis. Other materials are available for special operating conditions.

In the complete line of I-R chemical pumps, you'll find a unit that's *right* for practically any application . . . a pump that is completely engineered for maximum performance, minimum maintenance, and high operating efficiency. For complete information, write to Ingersoll-Rand, today, asking for Bulletin 7095. Or, if you have a special pumping problem, contact your nearest I-R engineer. He will be glad to help you.

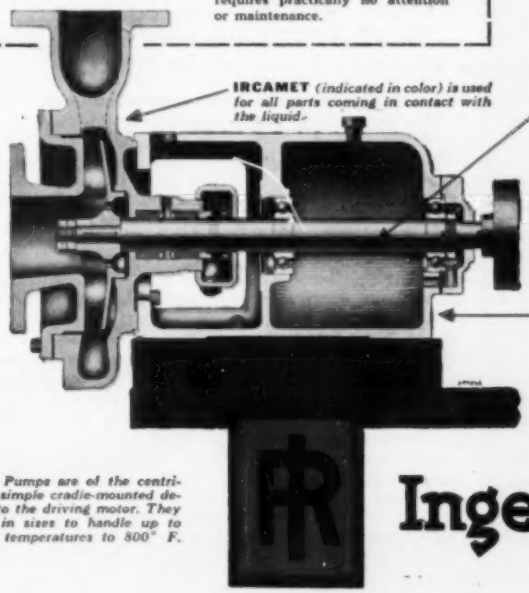
### ❷ They are PROTECTED AGAINST LEAKAGE —with the *LEAKOLLECTOR*

The patented LEAKOLLECTOR stuffing-box gland — an exclusive feature of all I-R chemical pumps — provides a simple and effective solution to the problem of pump leakage. It completely encircles the stuffing box, trapping all leakage so that it can be drained away for collection or disposal. The split gland is accurately fitted to both the inside and outside of the box, and will catch any seepage escaping between the shaft and packing, or between the packing and the bore of the box. The LEAKOLLECTOR is easily removed from the shaft for repacking the box.

### ❸ They are BUILT FOR EASY MAINTENANCE —and *LESS OF IT*

These pumps are ruggedly constructed to last longer on the job—and the simple design, with all parts easily accessible, means less "time out" for maintenance. The short, rigid stainless-steel shaft prevents impeller whip and eliminates many stuffing box troubles. The suction nozzle is removable, permitting access to the impeller without disturbing the discharge piping.

The CAMERON SHAFT SEAL can be installed on all I-R chemical pumps to replace the conventional stuffing-box packing. It eliminates stuffing-box leakage and requires practically no attention or maintenance.



**IRCAMET** *(indicated in color) is used for all parts coming in contact with the liquid.*

**STAINLESS STEEL SHAFT** *provides maximum strength, plus high corrosion resistance.*

**PANOFLAM,** *a modified, synthetic, resin-base paint, highly resistant to chemical action and to oil and grease, forms a protective coating over the entire unit.*

*I-R Chemical Pumps are of the centrifugal type, of simple cradle-mounted design, coupled to the driving motor. They are available in sizes to handle up to 4000 gpm at temperatures to 800° F.*

**Ingersoll-Rand**

CAMERON PUMP DIVISION 362-10

11 BROADWAY, NEW YORK 4, N. Y.

**HOW TO . . .**

1. **Switch from bags to bulk shipment?**
2. **Continuously convey a dusty material?**
3. **Cut down rubbing together of particles?**
4. **Handle a hygroscopic chemical in bulk?**
5. **Reclaim material from outdoor stock piles?**

# Can You Solve These Problems?

*Engineers at the recent conference of the Material Handling Institute in Pittsburgh set up an unusual kind of clinic. An engineer would pose a particular problem he had at his plant. Engineers representing manufacturers of material handling equipment would then suggest various solutions to the problem. The report on this conference is the basis of this QED feature.* —Ed.

## Problem 1

A company sells 1-4 carloads per month of semi and free-flowing dry chemicals to many of its customers. It currently ships the chemicals in multiwall paper bags which hold 50-100 lb. and cost 10-20 c. each. The selling price must cover cost of product, bags and labor in packaging and shipping.

The company would like to ship in bulk, using hopper bottom cars. Resulting savings would be passed on to the customer in lower prices for the product. However, the customer must put in facilities to receive and handle bulk shipment. And many interested customers fear conventional facilities will be too costly.

Would it be wise to install these facilities?

**Solution**—Two difficulties arise in handling this bulk: unloading materials from the car into intermediate storage; and transferring it from storage to points of use.

For unloading: Offhand estimate for pneumatic unloading equipment is $8,000. However, pneumatic conveying would have corrosion trouble because it feeds moisture to possible hygroscopic and corrosive materials. En masse conveying has its selling points. It gets around the moisture problem and is less expensive.

For transferring: Suggest use of portable bins (see *Chemical Engineering*, May 1952). (1) a silo capable of holding contents of car and a half, and 10 bin boxes needed to transfer materials from the silo to points of use. (2) instead of the silo, 40 bin boxes capable of holding the same amount. Estimated cost would be the same.

Fork trucks are out because of hazardous vapors in the area. Customer would have to buy air-operated or explosion-proof lifting and tilting equipment.

Reasonable estimate of total cost: $15,000-25,000. It could be amortized in a brief period. Customer would also find additional savings in his own operations to justify expense.

If a vibrating system is put in, the product would kick up dust when dropped from kettle to conveyor. Therefore, the discharge unit should be booted under slight negative pressure.

## Problem 2

It is desired to handle activated carbon from kilns to crushers by some mechanical means, such as automatic conveyors. While it seems easy, the following conditions complicate the problem:

1. The line of kilns make activated carbon in granular form in various particle sizes.
2. The conveying equipment is expected to function under continuous production—365 days a year.
3. The various meshes of carbon must reach the end of the line uncontaminated.
4. The carbon must be delivered to the crusher bins that are equipped with bucket elevators (for feeding further processing equipment). The automatic conveyors should permit the continued use of these elevators.
5. The conveyor system must deliver non macerated or pulverized product.
6. The product from the kiln becomes incandescent if exposed to air currents.
7. When delivered to the conveyor, the product would be dry but very slightly hygroscopic.
8. Ambient room temperature may be as high as 140 deg. F.
9. Perhaps the greatest obstacle is the dust. It could contaminate any conveying system.

The present system of production and handling is manual. The product accumulates into drum-type containers and then moves to the crusher bins. Before transferring the product into the bin, its condition is manually checked and a production record made.

Automatic conveyance is required. Its travel distance is over 500 ft. Kilns are 21-ft. wide, and spacing between each is 5 ft. Crusher bins are located in the same room in almost a central position. Any conveyor system must connect all kilns to permit continuous production.

**Solution**—Consider a zipper conveyor. However, this type of conveyor, lets dust escape. Although the pneumatic system has its points, the best system is a vibrating conveyor. It would be partitioned and fully enclosed to prevent circulation of dust.

## Problem 3

What is the best way of handling malt and corn grits after cleaning?

The materials are received by truck or rail, elevated 140 ft. to top of a brewery, and distributed to a series of bins that are 140-ft. deep and occupy an 80 x 80-ft. floor space. Then the materials are drawn out from the bottoms of the bins, blended, put into other bins, then moved to the processing department.

Amount of malt to be handled is 60 tons. The volume is the same for corn grits, but, being heavier, the weight-rate of this material is 90 tons per hour.

There must be a minimum of rubbing together of particles; no dust at transfer points. And air is to be drawn from the bins at the same rate that the bin is filled, so that no dust is forced out of the bins. As in all food handling, sanitation is required.

In the past, these materials were raised to the top of the brewery by bucket elevators and distributed by screw conveyors.

**Solution**—Use an air handling system, operating on the suction prin-

# ionXchange



## *pioneers and leaders in ionXchange*

ILLCO-WAY "firsts" include manufacture of the first commercial two-bed De-ionizer . . . the first commercial mixed-bed De-ionizer . . . development and building of the first successful installation for beet-juice purification by ionXchange . . . and more recently the development of a similar process for the purification of crude glycerol. These and numerous other applications of ILLCO-WAY ionXchange technology are currently available for your products or processes.

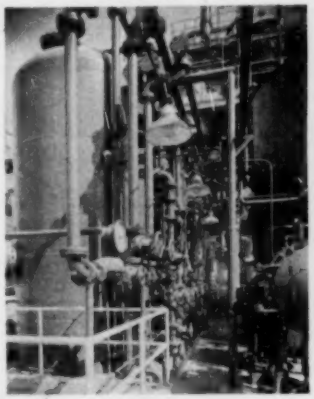
**ILLCO-WAY**

**DE-IONIZING**
**DE-ALKALIZING**
**SOFTENING**

*For complete data: see Sweet's File, Engineering, or Chemical Engineering Catalog*

## Glycerol by ionXchange

***Lever Bros. installation***



**Illco-Way equipment for purification of soap lye crude at Lever Bros., Los Angeles plant**

Purification of crude glycerol by Illco-Way ionXchange has proved to be both effective and economical at Lever Bros. Co. modern new plant in Los Angeles. Illco-Way De-ionizing eliminates the step of distillation normally used, and is estimated to give a 99% yield of C.P. glycerol as compared to a 66% yield by distillation. Cost of producing 1 lb. of 95% C.P. glycerol (starting with a sweetwater containing 15% glycerol and 0.4% ionized solids) is 0.45 cents. In addition, the de-ionized glycerol has considerably better shelf-life than the distilled product.



***Quick calculator***

A handy ionXchange calculator for conversion of water analysis has been developed by Illco-Way. The easily-read sliding scale is used to convert ppm to gpg or gpg to ppm. Also ppm or gpg to gpg as $CaCO_3$. This accurate pocket-piece is helpful to anyone operating water treatment equipment or to engineers specifying such equipment. Request for one of these calculators should be sent to Illinois Water Treatment Co., Rockford, Illinois, on your company letterhead.

PLATECOILS
REPLACE PIPE COILS

cut costs again

SAVE 5 WAYS



The C. A. Dauer Co., Detroit, Michigan, has found they get more efficient heat transfer at lower cost when they equip their bonderite systems with Platecoils. Use of Platecoils has these five advantages:

1. *Lower first cost.*
2. *Simplified and less costly installation.*
3. *Takes less space in tank.*
4. *Higher heat transfer rate.*
5. *No pipe joints in solution.*

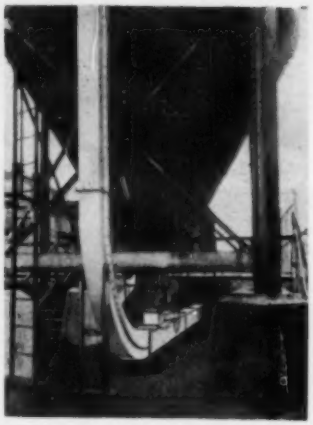
The 5-Stage Dauer Bonderite Washer pictured above has Platecoils in all five stages. It has electro-polished stainless steel Platecoils in the Bonderite stage and cold rolled steel Platecoils in the other four stages. Because the Platecoils have so much greater prime surface in a given area, smaller size Platecoils can be used. As a result, the initial cost is less, tank capacity is increased and installation is simplified. The Platecoils are easily installed, using simple supports instead of the complicated racks needed for pipe coils. As there are no threaded joints in the solution, the Platecoils are much easier for Dauer's customers to remove for cleaning or repairs. They can be removed and replaced without dumping the solution. Why continue to use costly pipe coils when Platecoils heat or cool so much more efficiently at but a fraction of the cost! Send for bulletin P61 today.

PLATECOILS *for* TANK HEATING *and* COOLING





QED, cont. . .



EN MASSE CONVEYING is preferred to pneumatic unloading in Problem 1.

ciple. This system would employ multiple car unloading hoses and a vacuum receiver on top of the silos. One riser pipe would handle both materials.

Air conveyors could carry the material to the bins. In fact, most breweries already use air conveyors.

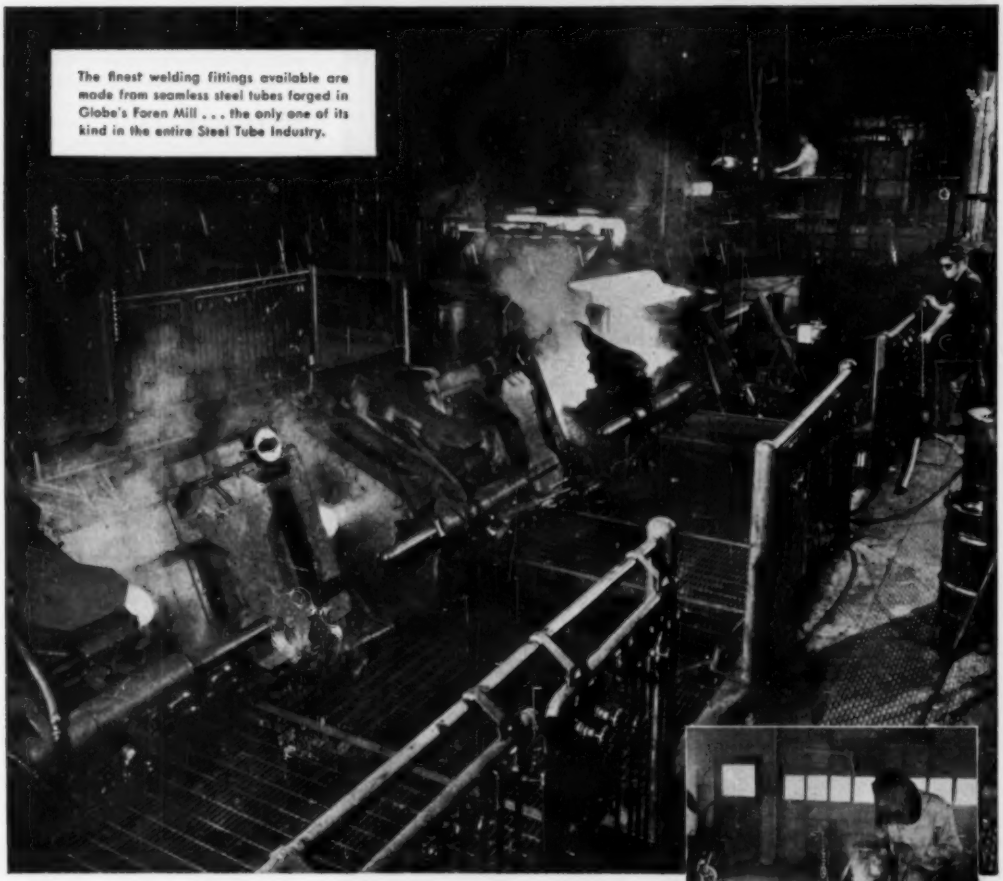
In drawing the materials from the bins, the system would use metering valves under the bins. Feeders with variable-speed drives could be used under each bin in the blending operation. This is new in a brewery, but not in other industries. As little as 2 percent of a blend may be taken from one bin.

2. The pressure-type air handling method is another answer. But the suction system is more effective for unloading cars and trucks. This system would pull air from the bins at the rate somewhat faster than the bins are filled, creating a partial vacuum and solving the dust problem.

Needed: The aid of a rotating air lock with pockets that discharge into the hopper feeding the screw conveyors. Since the screw conveyor outlets are over the bins, dust from the bins is exhausted through them to the suction system. Therefore, no dust collectors would be needed in this operation.

Screw conveyors are means of distributing the materials to the bins. Although not as completely self-cleaning, they are widely used and commercially satisfactory.

3. Vibrating conveyors have the advantage of being sanitary. No "dead" material can collect in them and they are easily cleaned. The en masse type of conveyor is still another possible




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WANT INCREASED PRODUCTION?

Viking Rotary Pumps Helped This Chemical Plant!



Stepped-up production has resulted from the complete new Viking Pump installation at Barker Chemical Company, Dolton, Illinois. With this battery of 15 Viking Pumps, still greater efficiency has been realized. Formerly using only 4 pumps, they had costly manufacturing shutdowns. **Better pumping may step-up your production. If you have a pumping problem, write for bulletin series 525C.**

VIKING PUMP COMPANY

CEDAR FALLS, IOWA

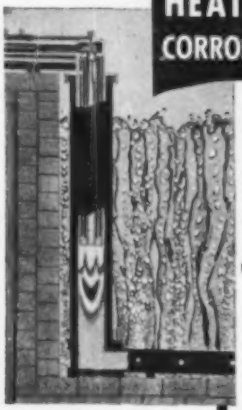
THE ORIGINAL "GEAR-WITHIN-A-GEAR" ROTARY PUMP



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Exposed view Submerged Combustion Burner as now used to concentrate calcium chloride and ferric chloride solutions.

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DIRECT FIRED GAS BURNERS

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- For rapid evaporation and concentration of acids, salt solutions, suspensions. Also for heating water and solutions.

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SUBMERGED COMBUSTION CO.

OF AMERICA, INC.

759 LOGAN STREET HAMMOND, IND.


QED, cont. . .

solution to the problem of elevating the materials and distributing them.

### Problem 4

Ammonium nitrate is made in ton quantities in a short cycle. Production room is about 50-ft. long and holds eight production vats, each 6 ft. in diameter.

An automatic conveyor system is desired. It would have to move in one direction. After the final product is checked and weighed, it is sent to the warehouse adjacent to the production room.

Principal considerations for this operation are:

1. The product delivered from the kettles, often is hard and lumpy. If so, it must be removed and returned for reprocessing.
2. Finished product is granular.
3. Discharge opening of the kettles is about 18 in. square.
4. Unloading should be held to 10 min.; the loading cycle to 20 min.
5. Operating conditions require vapor-proof equipment.
6. Finished product is extremely hygroscopic; hence maintenance could be a problem.

**Solution**—The vibrating conveyor is probably the best bet. Investigation indicated that labor requirements could be reduced by one or two men.

### Problem 5

What is the best method of handling large quantities of coal in and out of emergency stock piles operated in conjunction with a coke plant.

Outdoor area is about 800-ft. wide and extending approximately 2,000 ft. along a river. A total of approximately 1,700,000 tons of coal is stocked in 3 to 6 piles which normally are 30 to 50 ft.-high. At present, three types of coal are stocked and other grades may be stored in the future.

Handling is complicated by the erratic flow of coal to and from this stock pile. Receipts can be as much as 24,000 tons per day and are divided about equally between rail and barge. Shipments can be as high as 36,000 tons per day, most of it by barge. It is possible that once or twice a year the system might be called upon to receive 500,000 tons in a single month and to ship 600,000 tons in another month.

It is desired to develop methods and facilities to replace a coal bridge equipped with two 6-ton buckets which serve the most active coal pile. This bridge also loads and unloads barges with coal moving from and to

the other piles not serviced by the bridge. New facilities should offer greater flexibility and serve all coal piles equally well.

**Solution**—To stock pile the coal use a barge unloader, belt conveyor and self-powered earth moving and compacting equipment. The specifications for each to be determined by the exact layout.

For de-stocking: (1) tunneling and (2) expanding utilization of motorized equipment.

The tunneling operation would require a series of parallel closed trenches at ground level approximately 50 ft. apart and extending back from the river the depth of the coal pile. Belt conveyors installed in these trenches would be fed from electrically controlled gates at 25-ft. intervals through which the coal would fall by gravity.

De-stocking would be worked around the perimeter of each coal pile, and coal would be pushed by bulldozer to the conveyor gates. This system is considered efficient for stocking-out, not for stocking-in operations.

Motorized equipment is good for both stocking-in and stocking-out. A fleet of seven or eight units of 21-yd. capacity could handle 20,000 tons per day and additional units could be leased to handle peak loads. This equipment can haul capacity loads up 15-percent grades and is particularly useful in compacting and reclamation work.

## PERSONNEL

### . . . *Psychological Needs*

"If I were to select only one basic formula for effective labor-management relationship, the Golden Rule would be it."

Col. John Slezak, who spoke before the recent Personnel Conference of the American Management Association, believes employees should be asked as individuals to help solve the company's problems.

"You must be honest and sincere about it and set up your organization so that they can help you with your problems. The suggestion system, even the best administered one, provides only part of the answer.

"This approach is effective because it essentially tends to satisfy the main psychological needs of the employees. You recognize him as an individual; you give him a sense of belonging; he is part of the team, not an outsider. You give him a real chance to be heard, to express himself, and you give him a chance to be proud of his work. Of course you can assume that in such


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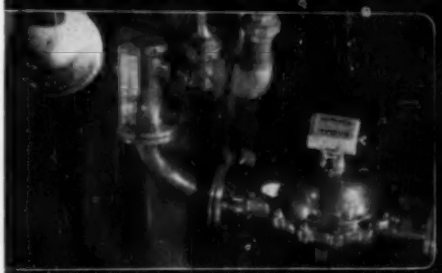
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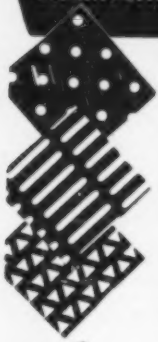
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Catalog No. 62 tells the "hole" story—write for your copy.

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**Rubber Pinch Valves for Abrasive Pulps and Corrosive Liquids**

**Patented "hinged" Rubber Sleeve**

Recesses molded into sides of sleeve act as "hinges" during compression, eliminating excessive strain and wear. These valves have been used successfuly for many years by various industries, wherever there is a problem of transporting abrasive or corrosive pulps or liquids. Here are some of the other proved advantages of these valves:

- **Long Life Under Severe Conditions**
- **Unobstructed Flow Passage**
- **Positive Closure on Solids**
- **No Working Parts in Contact with Pulps or Liquids**
- **Only ONE Wearing Part**
- **Withstands All Chemicals Not Harmful to Rubber or Neoprene**
- **Sizes from 1" to 12" dia.**
- **Withstands pressures up to 150 psi.**

New free **CATALOG** gives complete information on Massco-Grigsby Rubber Pinch Valves; Marcy grinding mills for laboratory, pilot plant and commercial grinding; laboratory crushers and pulverizers.

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QED, cont. . .

an environment he will receive fair treatment."

## CRUSHING

### . . . *Lateral Rod Action*

What is the difference in the lateral rod action of a coarse crushing mill and a fine or controlling rod mill?

"While it might be contended that this is only one man's viewpoint, nevertheless, the observations have been made in the presence of other engineers," said Tennessee Copper's J. F. Meyers to fellow crushers at the recent AIME meeting.

"In the coarse crushing mill, the fast shell speed (consolidated rod mill peripheral speed 670 ft. per min.) and the high lifter bars have minimized the compact area of rolling rods and amplified the number of free falling rods causing impacting in the toe area.

"Add to this the intense slugging action of the high lifter bars as they enter the toe area and it is obvious that the mill has a tremendous amount of impact crushing capacity which is essential for the comminution of coarse particles of ore.

"In the fine rod mill, the slow shell speed (Garms rod mill peripheral speed: 382 ft. per min.) and normal lifter bars intensifies the grinding action and controlling action of the rolling rods and minimizes the number of free falling rods for impact purposes. Consequently, the mill has an enormous capacity for producing a relatively fine and controlled product, but little capacity for much coarse crushing or impact work."

## COST ESTIMATION

### . . . *Backed by Experience*

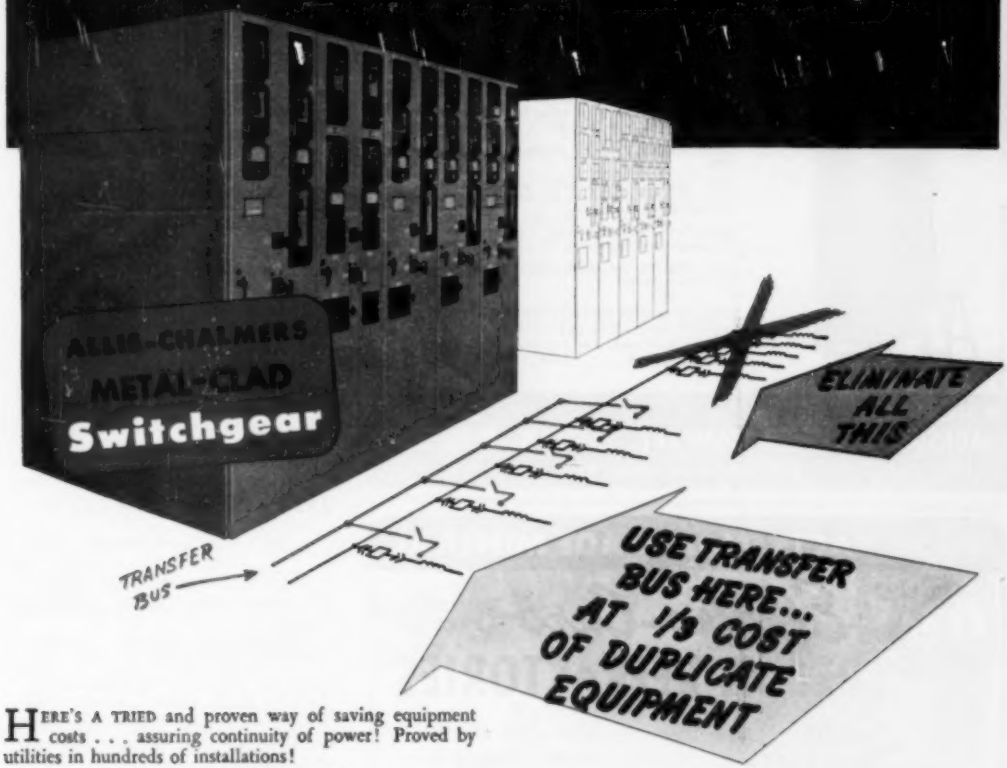
**Problem**—Recently in Manchester, England, J. F. C. Gartshore told members and guests at the meeting of the Institution of Chemical Engineers that the Dyestuff Division of Imperial Chemical Industries plans to make pure anthracene by a new process.

How to calculate probable costs before design reaches an advance stage?

**Solution**—It is unsafe, Gartshore believes, to compare the actual production cost at the running plant with the estimated costs of the new plant. The best method is to consider the established process as though it were a new one. Then calculate its probable costs on the basis of the new flowsheet.

Only in this way can such factors as amount of depreciation, and original

# Why Buy Duplicate Switchgear to Assure Power Continuity?




HERE'S A TRIED and proven way of saving equipment costs . . . assuring continuity of power! Proved by utilities in hundreds of installations!

**What is a Transfer Bus?**

It's simply a by-pass bus circuit that parallels the main switchgear bus. A switching means is provided so that loads can be transferred to the transfer bus. It's a standby in case anything happens to the main bus. Also, makes it possible to withdraw and maintain circuit breakers, or inspect main bus without power stoppage.

**What are Other Advantages?**

1. Saves Cost. Transfer bus costs about ⅓ as much as the additional equipment needed to provide duplicate switchgear to do this same job.
2. Cuts Space in Half. Allis-Chalmers supplies transfer bus in same cubicle as switchgear without adding cubicles. Thus an Allis-Chalmers installation cuts space one-half.

In addition, you can insure against failure of power source by providing a double end feed with the one set of switchgear and be as sure of power supply as if you had duplicate switchgear.

Depending on the job you want to do, there are many arrangements that Allis-Chalmers can provide. In many cases, the engineering has already been done.

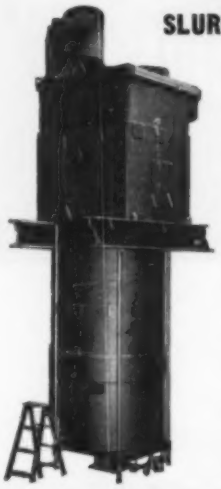
Ask an Allis-Chalmers engineer about transfer bus arrangements and what they can mean to your plant in savings and service. Call your nearby Allis-Chalmers district office, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-3731

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J-C Zenith Pulp Presses are becoming increasingly important to industry. Here are just a few of the many successful applications:

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Step up profits through improved pressing efficiency. For applications to individual problems, for performance data, write Dept. CE

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Especially so when Electro-Carb made Refractories, used for heat transfer, for example, showed a measurable 10-times increase in efficiency.

Facts and figures in almost telegraphic brevity are contained in Bulletin B-749. Sent on company-letterhead request. If you have a problem concerning the use of silicon carbide refractories, please submit it at the same time.

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QED, cont. . .

building and equipment costs be climinated. Experience has borne out its truth.

## MAINTENANCE

### . . . *Phase by Phase*

Preventive maintenance lets management, not the equipment, decide when repairs should be made. Maintenance men claim it reduces costs by making planning possible, and keeps operating and maintenance crews continuously employed without costly delays.

Before the recent Manufacturing Conference of the AMA in New York, Maintenance Engineer John Whitlock of Armco Steel Corp. recommended launching preventive maintenance phase by phase:

1. Inspection of equipment.
2. Daily work schedules based on the inspection.
3. An equipment log.
4. Regular replacement of equipment.
5. Study of each failure.
6. Application of the information in future design and procurement.

## INDUSTRIAL RESEARCH

### . . . *Genius in Oil*

What are the primary discoveries in the refining branch of the petroleum industry?

Thermal and catalytic cracking, alkylation and platforming, says Gus Egloff of Universal Oil Products Co. Each of these discoveries made possible new and better products, conservation of oil and increased efficiency in operations.

Some 37.5 billion barrels of oil have been conserved in the past 39 years through the use of thermal and catalytic cracking, says Egloff. Cat cracking has put great quantities of distillate fuel oil on the market—and at a time when domestic oil heating and dieselization of railroads were beginning to boom.

Alkylation made possible the production of large quantities of high octane aviation gasoline during World War II. Present-day 115/145 octane avgas is about 80 percent alkylate.

Platforming has attracted wide attention because it can produce a high octane motor fuel from a low octane charging stock, and also turn out high yields of aromatics—benzene, toluene and xylene. These are the basic raw materials of many chemical industries as well as top priority defense items.



## ELECTRODEPOSITING

### . . . *New Type Bath*

Bureau of Standards has worked up a new type organic bath for depositing aluminum.

"The bath consists of aluminum chloride dissolved in ordinary ether and also contains lithium or aluminum hydride. The presence of the hydride leads to production of dense, ductile deposits of aluminum, which will probably find use in plating other metals with aluminum and in electroforming wave guides for radio communication.

"It remains to be seen whether analogous baths may prove suitable for depositing other metals."

## AIR POLLUTION

### . . . *A Practical Solution*

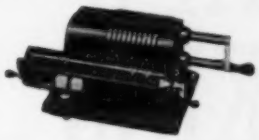
Blast furnaces making ferromanganese vent large clouds of dense fume to the atmosphere. Dust from a ferromanganese furnace is of two types. (1) Particles above 20 microns in size and comprise about 20 percent of the dust present. (2) Solids in the gas as it leaves the furnace—a typical fume, with particle sizes varying from 0.10 to 1.0 micron.

This spring, Research Associate C. A. Bishop told engineers at the Air Pollution Abatement Conference how U. S. Steel developed a practical method for removing and disposing ferromanganese fume.

1. Only three types of equipment, it appeared, could be considered for commercial installation: a high-energy requirement wet washer, a sonic coagulator and an electrical precipitator.

Although wet washers can clean ferromanganese gas, it is reported that maintenance costs are high because of the cementing properties of the fume. More important, wet washing would require a large scale water treating


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Motor price additional

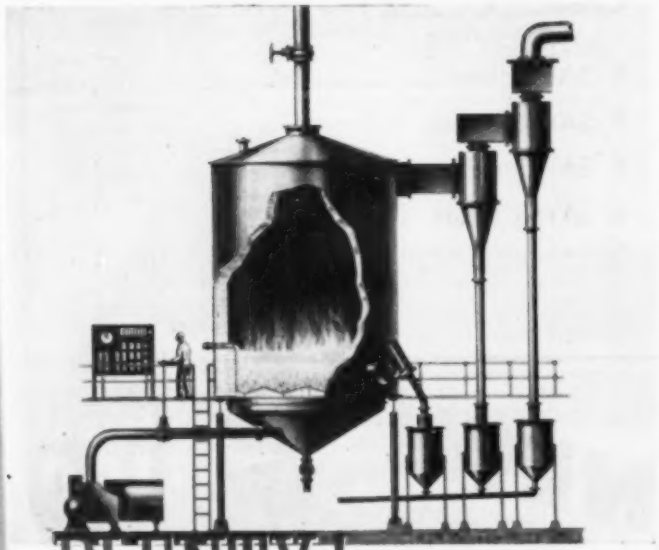
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READY . . . the new Neptune Pump which offers three-way economies! First, Model 100 is an astonishingly low-priced Chemical Proportioning Pump. Second, the advanced design delivers efficient and accurate performance. Third, the compact simplicity achieves low maintenance costs. Write for literature.

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Pressures to 300 PSI

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# WHAT'S COOKING *with the Sulphur Shortage* ?



PLENTY! One of the most recent developments is the Dorrco FluoSolids* system . . . already helping relieve the sulphur shortage.

Where sulphuric acid is made, or sulphur dioxide is used, this new FluoSolids system produces a higher gas strength than provided by conventional roasters . . . and it can process low content sulphide ores which conventional roasters can't handle. If you would like to know more about this Dorr development for roasting pyrite or other sulphide ores, just ask for a copy of Bulletin No. 7500.

Whenever you have a problem involving finely divided solids suspended in gases or liquids, or the use of ion-exchange, modern Dorr methods and equipment can help you find the answer.

*Another modern processing development by DORR*

Better tools TODAY to meet tomorrow's demand

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QED, cont. . .

plant in order to satisfy stream pollution regulations.

2. The sonic coagulator was considered and dropped. Reports indicated that a sonic unit, made from a horn-type speaker excited by a variable frequency oscillator and power amplifier, would agglomerate the fume.

3. Electrostatic precipitation was abandoned. The collection efficiency is high enough, but difficulties come up when companion equipment conditions, handles and disposes the dust. A more positive method seemed possible.

4. In the final phase, a spray tower would cool and condition the gas simultaneously. This tower, which was to operate without any water effluent, would cool the gas from an average temperature of 700 deg. F. to 350 deg. F. It would prepare the gas for an electrical precipitator.

5. For handling and treating the collected dust, we took advantage of the pyrophoric character of the material. We found that burned fume was easily wetted and could be formed into briquettes that did not disintegrate in water. For burning the fume, a kiln was adapted for use in the final pilot plant.

Briquetting was carried out using press rolls. They developed an estimated pressure well over 2 tons per sq. in. The rolls were driven at 1 rpm. to produce 74 small almond-shaped briquettes per minute.

## INDUSTRY

### . . . *Dynamism*

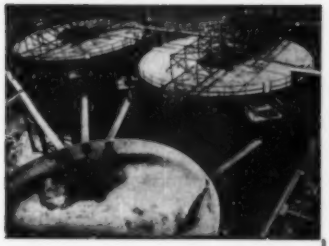
"The chemical business has exhibited a steeper growth curve than any other major industry in the United States during the last 25 years. From 1940 to 1950 twenty-four major companies showed an average growth of about 280 percent. In that same time the industry has more than doubled its plants and almost tripled its sales—there is no end in sight." Nolan B. Sommer, Jefferson Chemical.

## RESEARCH

### . . . *Patent Fall*

In the past 15 years the number of patents issued yearly by the U. S. has been dropping off. Considering we have four times as many scientists, twice as many engineers and an increased population today, this is indeed surprising.

Why? Speaking before the annual meeting of the AIC last month,



*if it's*

**thickeners**

*you need...*

*check*

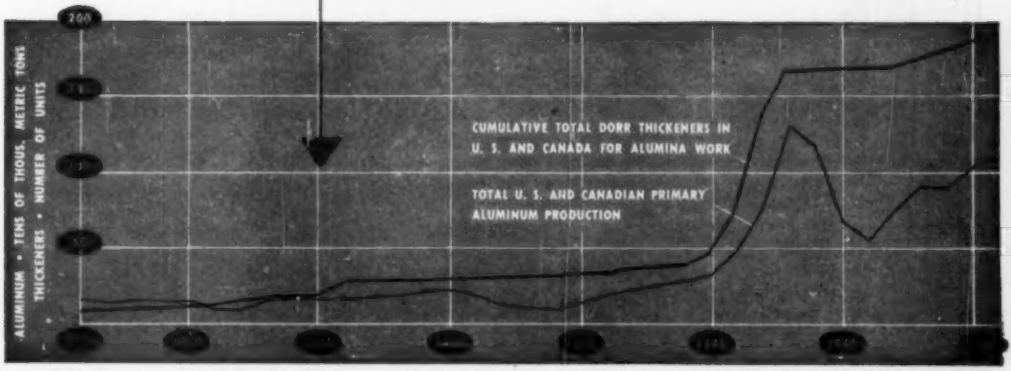
*the*

*record*

*of the*

**Aluminum**

*industry*




**1916** marked the installation of the first Dorr Thickener in the aluminum industry. Today, nearly 200 Dorrs... the majority big-capacity tray units... serve the industry in the United States and Canada alone. Elsewhere in the world, better than 200 additional units are installed for the processing of alumina prior to its reduction to metal.

We have gained invaluable experience in the handling of chemical processing problems from this long association. And the aluminum industry is but one of the many that pioneered with Dorr Thickeners... and has shown continuing faith in their use.

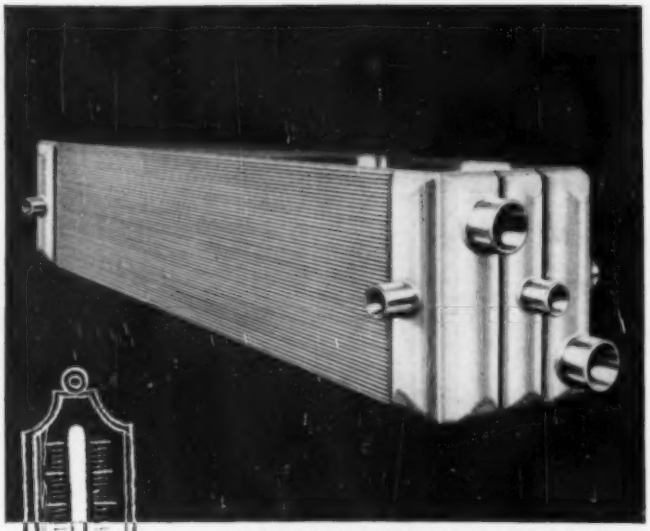
If it's Thickeners you need, regardless of size, type or use, it will pay to check Dorr... the oldest manufacturer of sedimentation equipment *with the newest ideas.*

Better Tools TODAY... to meet tomorrow's demand

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Multi-stream brazed aluminum heat exchanger unit by The Trane Company.

**HOW TO BE FRUGAL AT**

# -320°F.

If sub-zero process equipment means high material costs in your thinking, you're in for a surprise.

Aluminum saves 25% to 50% over other metals suitable for sub-zero service. And how suitable is aluminum? Down to -320° F., aluminum actually improves 23% in yield strength, 80% in elongation, 67% in tensile strength!

Look at more savings: In fabrication and installation, 50% lighter aluminum equipment is easier to handle. It is easy to weld, machine and cast, using standard equipment and standard techniques. Its chemical inertness and resistance to corrosion avoid batch and process contamination. Its high thermal conductivity and ductility speed filling of vessels with cold liquids, improve exchanger efficiency. Another way of saying aluminum smooths your processing problems.

Aluminum equipment is no stranger to tonnage oxygen, propane chilling, dewaxing and other sub-zero processes. Alcoa's development engineers are anxious to give you complete details. Simply write (on your company letterhead) to:

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ALCOA

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QED, cont. . .

American Cyanamid's E. H. Northey pointed to a few reasons.

"The impact of the war in diverting domestic scientific and engineering efforts to defense and in decimating foreign sources of patent application.

"More important probably are the more rigorous tests of patentability and greatly increased costs of prosecuting patents to issuance which have discouraged filing patents of marginal novelty and utility.

"The question is opened to discussion as to whether the law of diminishing returns is being felt in industrial research."

## WASTE DISPOSAL

### . . . *Burning Sulphite Liquor*

No doubt, a paper mill operator can best get rid of waste sulphite liquor by dumping it in the nearest waterway. But public opposition to such disposal has increased of late. More and more operators are faced by more and more legislation designed to prevent pollution of streams and harbors.

To date, many engineers feel that burning the liquor is the next best answer. Unfortunately, only a small fraction of sulphite liquor can be effectively and economically burned using present furnace designs and incinerator techniques.

This spring, H. A. Sorenson of Washington State College said he found a way to burn calcium-base waste sulphite liquor without the use of auxiliary fuels. Speaking before the recent meeting of the ASME in Seattle, he claimed the method may solve disposal problems for paper mills.

**How It Works:** Steam coils preheat the sulphite liquor at the bottom of the storage barrel. A gear pump delivers the liquor to the furnace through a regulating system installed to control pressure and flow.

A steam-atomizing oil burner nozzle fires the liquor. However, compressed air, rather than steam, is the atomizing medium. Spinning vanes, inserted in the burner head, mix up the air and fuel in the ignition zone.

Sulphite liquor burns with a long, orange-colored flame of medium brightness in the 8-ft. long, 3-ft. diameter refractory-lined combustion chamber.

At higher firing rates, combustion continues beyond the furnace into the transition cone. High heat loss occurs here. Probably the burner at the College's Division of Industrial Research, which produces a long flame pattern, causes burning within the cone.

At first, an oil burner, attached to the inlet end of the furnace, preheated the furnace for an hour before the sulphite liquor burner was cut in. However, oil firing, it was soon discovered, was unnecessary. Pilot ignition and combustion could be had with the liquor alone.

After a series of five test runs, Sorenson calculated a combustion efficiency of 76 percent—definitely low. He took furnace efficiency as the ratio of the actual temperature rise, inlet air to outlet gas, to the calculated corresponding temperature rise based on theoretically complete and adiabatic combustion, neglecting effect of dissociation.

A longer furnace will permit more complete combustion; but it will also make for an awkward structure. Sorenson feels a redesign in firing equipment would be preferable. Wanted: a shorter and more intense, turblent flame.

## PROGRESS

*. . . Why?*

"The influence of science on society has been considerably more profound than the material benefits for which we give it credit," says MIT's Tom Sherwood.

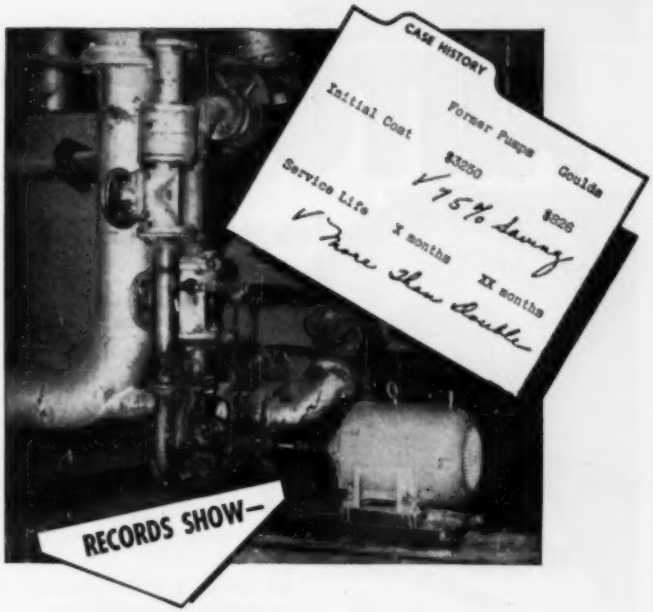
"The Romans in the days of the great Roman Empire lived an average of 22 years. When I was born my life expectancy was 49, but the new-born child today can expect to live 68 years. More years have been added to man's lifetime since I was born than during the preceding one thousand years.

"Since 1850 the work week has been shortened from 70 hours to 43 hours and the first generation of laborers in history has known leisure time. I estimate that a man today works about 80,000 hours in the course of his lifetime, sleeps 200,000 hours, and has 320,000 hours left for himself. His working hours represent less than 15 percent of the total.

"Leonardo da Vinci understood the principles of flight four hundred years before the Wright brothers first flew, which they did the year I was born. Today air travel is routine, and on this continent has passed Pullman travel in passenger-miles per year. Jet propulsion is but 10 years old, yet jet engines are now being used for air passenger service."

But why has the rate of scientific progress increased so rapidly during the last generation?

"It is true that we have many more scientists, but I see no evidence that they are greater scientists than Newton, Boyle, Carnot, Lavoisier, Faraday, Thomson or other great names of


**How a manufacturer cut costs tremendously with Goulds stainless steel pumps . . .**

**When handling corrosive liquids, pumps alone can be an important item in your processing budget. One alert plant engineer in the southwest cut his pump costs to about an eighth of what they had been.**

**The pumps he had been using for an especially erosive crystaline slurry cost $3250. When they wore out he replaced them with Goulds Stainless Steel Centrifugals for only $826. But this tremendous saving in initial cost was only half the pay-off. The Goulds pumps have already been in service *twice as long* as the ones they replaced . . . and they're still going strong.**

**The advanced design and simple construction of Goulds pumps make these savings possible. Bearings are prelubricated and fully protected. Stuffing boxes are under suction pressure to prevent leakage and assure long packing life. Parts are interchangeable. The impeller clearance can be adjusted for wear. Available in 9 sizes with capacities to 750 G.P.M. Send us the coupon today for full details.**

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QED, cont. . .

the past. I believe that the answer lies in the relatively new invention and development of a system for utilizing the results of science. This is the system of teamwork among scientists, engineer and manufacturer."

## BREAKING FROTHS

### . . . *With a Siren*

"Sound waves can be employed for continuous and instantaneous defrothing," says Professor Shiou-Chuan Sun. A powerful high-frequency siren can destroy extremely tough froths in a few seconds. Shiou-Chuan presented data to confirm his opinion at the recent meeting of the AIME in New York.

**Why**—Sound waves exert a radiation pressure against any obstacle they hit. When sound waves periodically smack a froth surface, the bubbles are broken. In addition, sound waves make the bubbles of the froth vibrate, causing collision and coalescence. Sonic wind and heat also batter the froth surface and share in the break-up.

**How**—To eliminate objectionable noise in industrial defrothing, the siren and the upper part of the frothing container could be enclosed in a soundproof cabinet.

Based on experience in his Penn State lab, Shiou-Chuan says, the inner wall surfaces of the cabinet should be lined with 6-in. cotton, or other suitable sound-absorbing material. The siren should be supported so that its elevation and horizontal position can be adjusted with the least amount of effort.

## EDUCATION

### . . . *Pragmatic Complex*

"As scientists, we have not done a good job in education of the general public to the thrill of intellectual discovery of new knowledge. The public thinks too much of science at the level of end-product invention rather than in terms of discovery of new principles."—E. U. Condon, Corning Glass Works.

## PLASTICS

### . . . *Recent Progress*

How are the newer resins sizing up today?

"Of the newer resins, the epoxys (essentially bisphenol-epichlorohydrin

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Placing the complete job with this large, experienced organization assures a refinery that fully meets pre-determined requirements. Numerous plants — Bechtel-designed and built — are operating profitably for their owners.



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Protecting surfaces from deterioration is a "natural" for rubber-base paint. Parlon (Hercules chlorinated rubber) in protective coatings adds specific resistance to the action of chemicals, gases, moisture, mold growths, and other destructive agents.

Parlon rubber-base paint dries fast . . . seals and protects surfaces . . . resists acids, alkalies, fumes, and salts three to four times longer than ordinary coatings. Rubber-base paint is especially helpful in solving maintenance problems for laundries where moisture, humidity, and alkaline solutions are present, and for roadstands where kitchen heat and fumes are part of the working environment.

Parlon rubber-base paint is particularly durable on concrete because of its resistance to free alkali in cement. Ask your paint supplier about easy-to-apply and economical-to-use rubber-base paint—or write direct for details.

*HERCULES POWDER COMPANY*
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*952 Market St., Wilmington 99, Delaware*

RUBBER-BASE (PARLON)® PAINTS

CR52-3

QED, cont. . .

condensates) are reaching sizable production because of increasing usage in coatings, adhesives, potting compounds, prosthetics and stabilizers for chlorine-containing resins.

"Fluorine resins are finding many uses although their relatively high price still limits application to specialties.

"Another new material, triallyl cyanurate, has greatly extended the use of polyester resins by enhancing their heat resistance. Rubber-phenolic blends, a rather new combination of old materials, are also finding wide acceptance," says E. E. McSweeney of Battelle Institute.

## METALS REFINING

*Continued from page 168*

sulphuric acid and again with water. The acetic acid removes traces of lead and the sulphuric any of copper oxide. The copper powder is then dried in an atmosphere of hydrogen at 600-700 deg. F.

### ZINC RECOVERY

After copper has been removed, zinc is recovered from the liquor. A rapid vacuum distillation first removes part of the ammonia and carbon dioxide. At this point, zinc carbonate, preferentially to copper carbonate, precipitates. Ammonia and carbon dioxide are recycled.

The zinc carbonate is cooled, filtered and washed, then dried and sold as basic zinc carbonate. Alternatively, zinc metal can be recovered electrolytically.

Lead, tin and manganese remain in the leach tank. These metals are recovered by settling and filtration as oxide slimes.

All equipment to the reduction step is mild steel. Thereafter, to safeguard copper powder from iron contamination, all equipment is stainless steel. Carbon monoxide for the reduction can be made in a standard reforming unit.

A plant handling 50 tons a day of copper scrap, containing about 75 percent copper and 25 percent zinc, might cost upwards of $2 million. Direct operating cost would be around 2c. per lb. of copper output, charging all costs to copper. Thus any zinc recovered would provide an attractive added profit.

### MANGANESE FROM U. S. ORES

When the Russians cut off manganese in 1950, the crisis spurred work that has culminated in the Chemico process for getting manganese from

# How in the world would **you** have solved these connector problems?

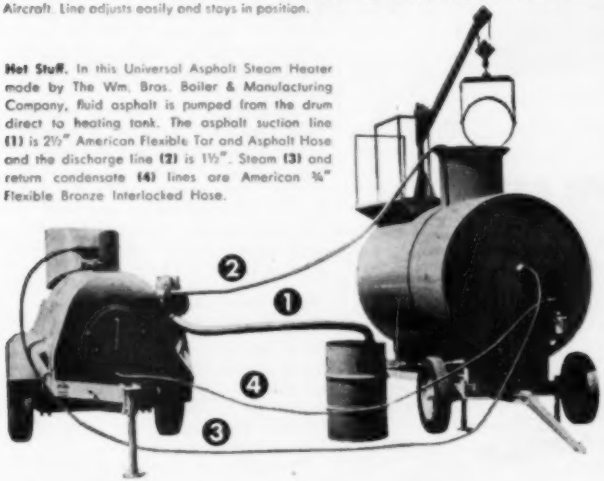


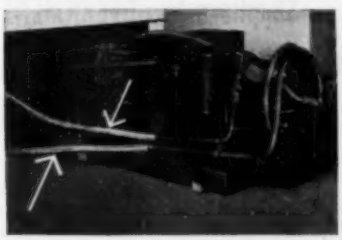
**Coolant gets a new twist.** A quick twist, and American Flexible Metal Tubing conveys coolant to just the right spot on this special lathe which machines jet engine parts at Pratt & Whitney Aircraft. Line adjusts easily and stays in position.

Would you have relied on costly, clumsy, rigid piping? Thrown up your hands? Or – like the resourceful designers of these three machines – would you have used flexible metal tubing? In each case American Flexible Metal Hose or Tubing filled the bill . . . and cut operating costs.

Your product, too, may need versatile, flexible American Metal Hose. If it must move, bend, or vibrate, let us show you the right connector...designed to absorb vibration, connect moving lines, or to be assembled in close quarters, while resisting heat, cold, pressure and corrosion in conveying liquids, gases or semi-solids. Write for Bulletins SS-50 and CC-300 which give technical details and many application histories. The American Brass Company, American Metal Hose Branch, Waterbury 20, Conn. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

**Hot Stuff.** In this Universal Asphalt Steam Heater made by The Wm. Bros. Boiler & Manufacturing Company, fluid asphalt is pumped from the drum direct to heating tank. The asphalt suction line **(1)** is 2½" American Flexible Tar and Asphalt Hose and the discharge line **(2)** is 1½". Steam **(3)** and return condensate **(4)** lines are American ¾" Flexible Bronze Interlocked Hose.



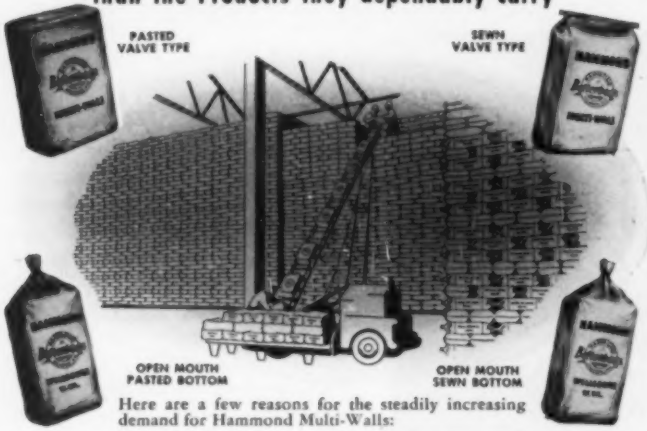
**Pull-out is a push-over to repair.** Tyler Fixture Corp. neatly solved the problem of permitting quick inspection and easy repair of the refrigerating unit in their freezers. Entire unit pulls out, yet refrigerant lines remain connected – thanks to American Seamless Flexible Bronze Tubing.

ANACONDA

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low-grade U.S. ores. So overwhelmingly important strategically is manganese, that even though alumina from clay might be more attractive commercially, Chemetals decided to go ahead on recovery of manganese.

The sulphur dioxide leaching process was picked because comparatively low-cost $SO_2$ is easy to get and because this process can be adapted to many ores. A high-pressure high-temperature oxidation step added to the leaching operation gets rid of impurities and prevents formation of thionates that formerly caused large sulphur losses. The process overcomes difficulties encountered in operation of a Nevada leaching plant for the government during World War II.

### STEPS IN PROCESS

In the Chemico process for getting manganese oxide sinter from low-grade ores, the ore concentrate is first leached with sulphur dioxide. Next, it's oxidized with either air or oxygen in an autoclave while under pressure and at elevated temperature. After that, manganous sulphate crystallizes out and is separated by filtration. The crystals are sintered, driving off $SO_2$, to produce the oxide, principally $Mn_3O_4$.

After semi-pilot plant investigations, Battelle has endorsed the process as the best of many it has tried for recovering manganese.

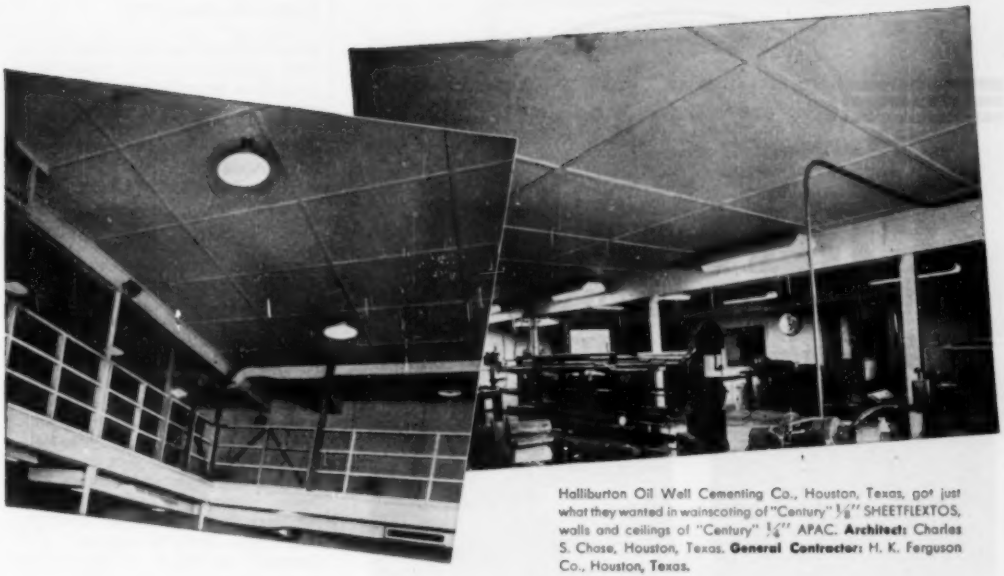
Using ores from Minnesota's Cuyuna Range and ores from Cuba, Battelle was consistently able to extract from concentrates up to 90 or 95 percent of the manganese. These ores, which contain about 4 percent manganese, can be beneficiated by gravity methods to a 20 percent manganese concentrate.

As feed for the Chemico process, this concentrate produced a sintered oxide product containing the equivalent of 60-62 percent manganese. The product contains from 16 to 19 times as much manganese as iron, and is low in phosphorus and sulphur. It's ready for the electric furnace, for upgrading, or the stockpile.

### PRODUCTION PLANNED

Chemetals has brought together an operating group, Utah Construction Co. & Associates, to strip, mine, concentrate and chemically refine an estimated 50 million tons of low-grade Cuyuna manganese ore, using the Chemico process.

Production is planned at 100,000 long tons per year of manganese as sintered oxide. President Hayden of Chemetals reports that if the government contracts for the output, Ucoa will undertake a $30 million project.



Halliburton Oil Well Cementing Co., Houston, Texas, got just what they wanted in wainscoting of "Century" 1/8" SHEETFLEXTOS, walls and ceilings of "Century" 1/4" APAC. **Architect:** Charles S. Chase, Houston, Texas. **General Contractor:** H. K. Ferguson Co., Houston, Texas.

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*ASBESTOS-CEMENT SHEETS*

Halliburton Oil Well Cementing Co. wanted strong, good-looking walls and ceilings that would be *fire-resistant* and *easy to clean*. That's why they chose "Century" SHEETFLEXTOS for wainscoting applied over solid sheathing and "Century" APAC secured right to studs and joists for upper walls and ceilings.

Fire-resistance, of course, is an outstanding feature of these structural boards, combined as they are of virtually indestructible asbestos fiber and portland cement. Ease of cleaning, too, comes "naturally" to their hard, smoothly-textured surfaces that can't be hurt by water, dampness, or rot, and need no protective painting.

But look at the *extra* features that go with "Century" APAC and SHEETFLEXTOS. Both Sheets are also resistant to rodents, immune to termites. They go on fast, in big sheets (standard 4′ x 8′) that can be cut or drilled on the job, and fastened easily with screws or ring-fettered nails. They obviate the need for laths and plaster, and, while they require no painting at all, they take decorative colors well. SHEETFLEXTOS, as its name implies, has the added advantage of flexibility, to make curves and domes where indicated.

Both "Century" APAC and "Century" SHEETFLEXTOS make good surroundings for successful work and enjoyable living. Figure on one or both for your attractive, fire-resistant interiors. Write us for further details about these economical products . . . and name of your nearest distributor.

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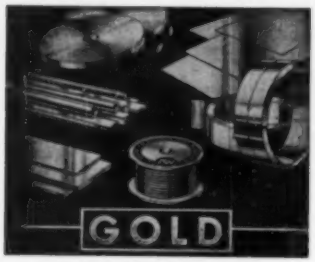
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including a $17 million plant to produce manganese oxide of metallurgical grade from these low-grade Minnesota ores.

Meantime, autoclaving at the Linden pilot plant indicates that ores from Aroostook County in Maine make good feed for the Chemico process. These ores, which occur in tremendous quantities at or near the surface, contain from 10 to 15 percent manganese. Another possibility: the steel industry might be able to use the process in extracting manganese from blast furnace slag.

### STORY OF A PROCESS

How did it all begin? Back in 1934, Edward S. Roberts, now vice president and chief engineer of Chemico, while working at a plant near Viglini, Italy, alertly spotted almost pure copper depositing, under certain abnormal conditions, around the carbon monoxide exit of an ammonia recovery scrubber.

In 1940, Roberts suggested that Chemico investigate a process for cheaper production of ammonia. Roberts talked this over with Dr. Ludwig J. Christmann, then directing nitrogen research at American Cyanamid's Stamford, Conn., laboratory. Christmann came up with many possible uses for cheaper ammonia. Among them: several metallurgical applications, including leaching of copper ores.

In 1945, when he became Chemico's chief engineer, Roberts launched an inorganic research project that resulted in the new metallurgical process.

### TWO LEACHES AND A REDUCTION

Then in 1946, Patrick J. McGauley, now chief of the metals department, joined Chemical Construction. "They hired me," McGauley says, "because they needed someone who knew something about copper." He had been brought up in the heart of British Columbia's mining area, one of the world's largest, at Trail.

Rolling up his sleeves and getting to work, McGauley solved some of the toughest problems that had blocked progress. Within two years, he had come up with two leaching processes, first an ammonia and then an acid leach. More important, he developed the critical reduction process. His leeching and reduction method for copper ore concentrate results in a 99.9 percent pure product, with close to 100 percent extraction. This established the fundamental technique for acid leaching and the separate reduction of pure nickel and pure cobalt powder from the leach solution. As operation engineer, McGauley will

shortly take over the critical and significant job of starting up Howe Sound's cobalt refinery, the world's first to use the Chemico metals separation process.

BROWN MUSES

Meantime, up in Canada, after a dozen years of prospecting, the first drill bit through to the ore body at Lynn Lake in 1946, and Sherritt Gordon was started on the biggest venture in its career.

Here was nickel-copper ore, deep in the northern wilderness, nearly 150 miles from rail's end. Over-all grade was not high.

Would it bear the huge cost of roasters, blast furnaces, converters and an electrolytic refinery, all big and expensive, and all needed for the reduction of nickel ores? Maybe, mused Sherritt's President Eldon L. Brown, it wouldn't have to.

After all, a successful leaching process had been developed and a plant built during the war to treat oxide ores of the Nicaro mine in Cuba.

He dumped the problem into the lap of Professor Frank A. Forward, head of the department of mining and metallurgy at the University of British Columbia, where many tough ore dressing problems had been licked.

FORWARD COMES THROUGH

By 1947, Forward, true to his name, was well along on his pressure autoclaving process for leaching with ammonia. By spring 1948 he had successfully adapted his process to the complex copper-nickel-cobalt ore from Lynn Lake. Sherritt could not hope to get into production without putting up a big and costly smelting plant.

In December 1948, Sherritt Gordon called in Chemico's engineers to take a look at Forward's process. With his process, copper, nickel and cobalt were to be leached directly from the finely ground sulphide concentrate with strong ammonia and oxygen, the nickel to be recovered as an oxide.

CHEMICO JOINS SHERRITT

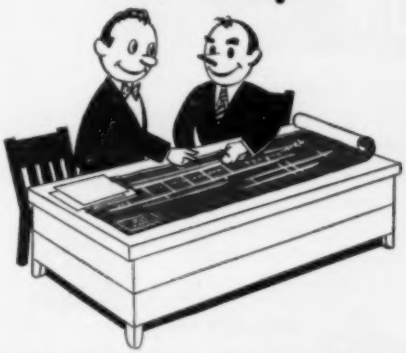
Chemico's engineers decided that some of their own techniques could be combined with Forward's to produce nickel as the end product, at the same time cutting costs. The two companies teamed up.

Sherritt Gordon, helped out by Chemico engineers, built and operated a pilot plant for ammonia leaching in buildings of the Mines Branch of the Department of Mines and Technical Surveys in Ottawa.

At the same time, Chemico at its Linden, N. J., pilot plant and at Cyanamid's Stamford, Conn., laboratory developed production of pure nickel powder from the nickel salts


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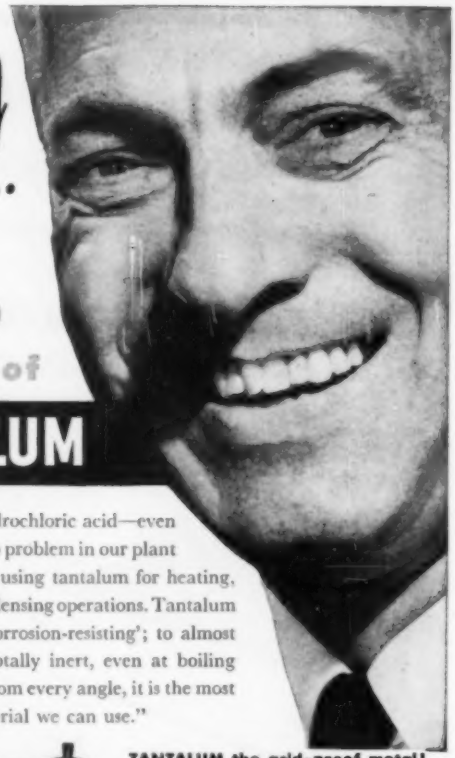
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**Use TANTALUM With Economy**
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**Tantalum Steam Coil.** Additional heating capacity obtained by building coil on large steel flange protected by tantalum tube sheet, eliminating risers. Connections are at bottom.

Write for the Fansteel booklet, "Tantalum Acid-Proof Chemical Equipment", and consult Fansteel for designs and recommendations.




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produced at Ottawa from purified leach solution.

Later, Sherritt Gordon constructed a demonstration plant in Ottawa to complete the piloting of its own ammonia leach process, together with Chemico's process, and to promote these developments in Canada.

Chemico's Sydney Nashner was loaned to Sherritt to assist on the pilot plant job at Ottawa. He's now busy on final designs for the commercial plant.

Draftsmen are busy on design work in the Toronto headquarters of Chemical Construction's recently organized subsidiary. Construction work at Fort Saskatchewan is just getting under way.

Sherritt Gordon holds some of the patents, principally on the ammonia leach, and Chemical Construction has the others, chiefly on the acid leach and the reduction to powdered metals. Both will share royalties.

#### NATIONAL LEAD AND HOWE SOUND

From December 1949 to June 1950, Chemico did research on the cobalt-copper-nickel concentrates from National Lead's Fredericktown mine. This resulted in improved separation of nickel and cobalt.

Another research project, begun in 1949, led to the adapting of Chemico's process to the needs of Howe Sound, faced with the tough problem of getting rid of high arsenic content in its cobalt concentrate. Chemico's solution resulted in construction of the Utah cobalt refinery that starts operating next month.

#### CHEMETALS ORGANIZED

In December 1949, Chemetals Corp. was organized by Hayden and a group from the mining and metals industries. Its purpose: to develop, together with Chemico, a process for getting metallic copper powder from copper scrap, brass scrap and blister copper.

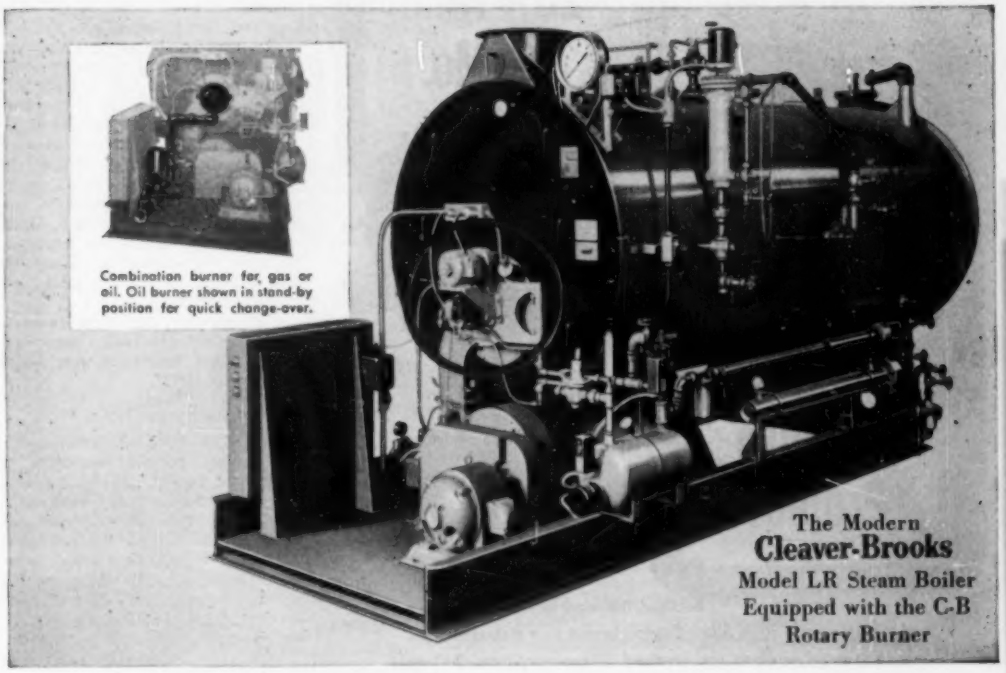
Recognizing the tremendous economic potential of the process, Hayden had resigned as head of industrial research for Anaconda Copper Mining Co. after Anaconda had decided not to use the process in treating copper concentrates from its big Chuquicamata mine in Chile.

Together with Chemical Construction, Chemetals faced squarely the challenge of chemically extracting prime copper and zinc from an ever increasing supply of brass, bronze and copper scrap.

#### LINDEN PILOT PLANT

In April 1950 construction of a pilot plant was begun at Chemico's

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Linden, N. J., experimental station. Chemico and Chemetals cooperated in construction and operation. Expense of initial research was borne by Chemico, while all further research, engineering facilities and other piloting costs, estimated at $750,000, have been met by Chemetals.

George F. Van Hare, Jr., a chemical engineer who had been one of the first assigned to the Sherritt Gordon and Howe Sound jobs and who had solved many practical engineering problems on those projects, was put in charge of the Linden pilot plant by Chemico. Engineering director for Chemetals at the outset was Curville J. Robinson, now in Europe. In mid-1951 Richard B. Montgomery, a chemical engineer with 30 years of experience in nonferrous metals, 20 of it with American Brass Co., came out of retirement to head engineering for Chemetals and help get the Linden pilot plant running smoothly.

First powder producing run was made on July 21, 1950. Brass scrap leaching and treatment were begun in February 1951.

#### EYES ON MANGANESE

After successfully demonstrating that copper powder equivalent to electrolytic copper can be economically recovered in plants handling as little as 25 tons of scrap per day, Chemico and Chemetals have since September 1950 been teamed up on the manganese process. They are now getting ready for tests in a pilot plant handling 5 tons of manganese concentrate a day.

Under an exclusive license from Chemico, Chemetals will sublicense the copper scrap process in the U. S., Canada, Mexico and the United Kingdom. It has preferential rights elsewhere, with an option to exclusive world rights after four years.

The right granted to Chemetals by Chemical Construction to sublicense the manganese recovery process is exclusive in the U. S., Canada, Peru, Brazil and Mexico. It may later become exclusive throughout the world. On all licenses granted so far to Chemetals, royalties will be split equally with Chemico.

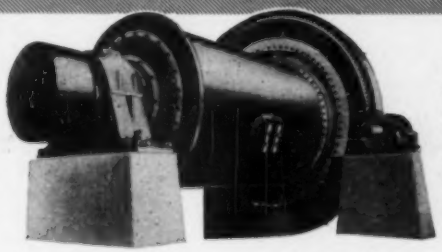
#### CHEMICAL REFINEMENT

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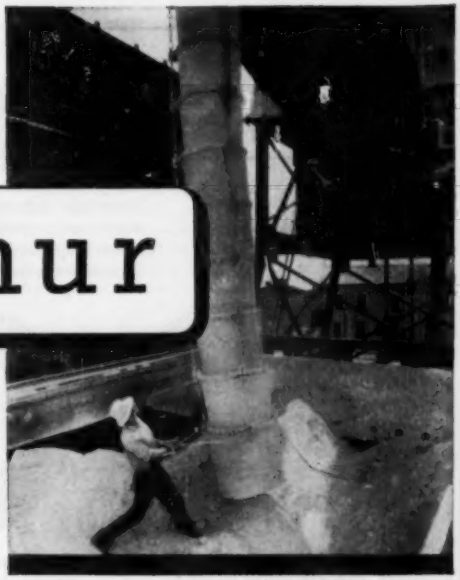
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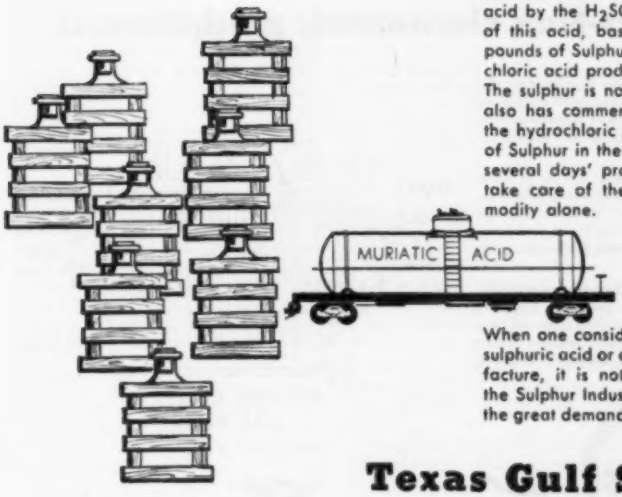


Loading a ship with Sulphur at Galveston

***Thousands of tons mined daily, but where does it all go?***

PARAPHRASING an old saying: 'It takes a chemical to make a chemical,' certainly applies to hydrochloric acid.

No chemical engineer has to be told how hydrochloric acid is made but sometimes with the mind focussed on the word "hydrochloric" little thought is given to another word "sulphuric." It is this word that calls attention to the fact that to make one net ton of 20° Bé hydrochloric acid by the $H_2SO_4$ process requires about 950 pounds of this acid, basis 100%, which is equivalent to 320 pounds of Sulphur. About one third of the annual hydrochloric acid production is made by the use of sulphuric. The sulphur is not lost because salt cake, a by-product, also has commercial value. But any way you figure it, the hydrochloric acid industry is an important consumer of Sulphur in the form of sulphuric acid. In fact, it takes several days' production from all the Sulphur mines to take care of the annual production of this one commodity alone.




When one considers all the other chemicals that require sulphuric acid or other Sulphur compounds for their manufacture, it is not difficult to appreciate how faithfully the Sulphur Industry is serving industry today in spite of the great demands made upon it.

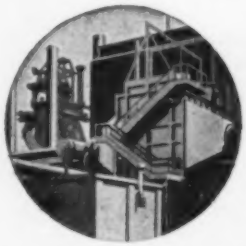
**Texas Gulf Sulphur Co.**

75 East 45th Street, New York 17, N. Y.

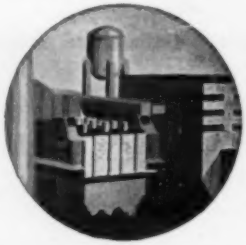
Mines: Newgulf and Moss Bluff, Texas

# War on waste!

American industry is continually searching for new ways to stop waste and increase production and efficiency. A good example of this is the Koppers-Elex electrostatic precipitator. Shown below are a few typical ways industry uses them to combat waste . . .



**BLAST FURNACE GAS** must be cleaned before it can be used as a fuel. Koppers-Elex electrostatic precipitators clean this gas to residuals as low as .002 grain per cubic foot.



**FLUE GASES** from recovery boilers in pulp mills contain valuable materials. Koppers-Elex electrostatic precipitators recover several hundred thousand dollars worth of these materials yearly.



**FLY ASH** from power plants and factories may drop a blanket of dust extending three to five miles. Koppers-Elex electrostatic precipitators stop this nuisance and preserve public good will.

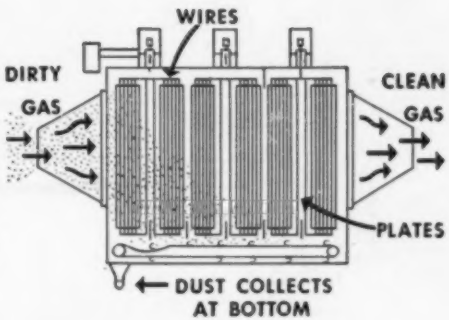
**Guaranteed:** All Koppers-Elex electrostatic precipitators are guaranteed to equal or better (under tests made by your own personnel) any efficiency or residual content you specify.

## *ENGINEERS!* You should know about these six design features of Koppers-Elex electrostatic precipitators!

KOPPERS has made sweeping improvements in electrostatic precipitator design! For example, double chambers eliminate expensive by-pass systems and the resultant loss of materials during inspection or maintenance. And re-entrainment is sharply reduced because rapping is sectionalized.

Successive collection zones are separately energized to provide maximum voltage for highest collection. And because each field is, in effect, a separate precipitator, the outage of one field *does not stop* gas-cleaning action. In addition, completely enclosed and compact "package" mechanical or vacuum tube power packs simplify installation and operation.

Another exclusive Koppers feature is the drag scraper which provides continuous dust removal, eliminates plugged hoppers and prevents bothersome dust build-up. For detailed information on recovery, gas-cleaning or nuisance abatement results write today to: Koppers Company, Inc., Precipitator Dept., 216 Scott Street, Baltimore 3, Md.




*If you have a gas-cleaning problem, write today to: Koppers Company, Inc., Precipitator Dept., 216 Scott St., Baltimore 3, Md.*

KOPPERS

*Koppers-Elex* ELECTROSTATIC PRECIPITATORS

# Chemical Engineer's Bookshelf

*Edited by Lester B. Pope*

### Bibliography

TREATISE ON POWDER METALLURGY. Vol. III. By Claus G. Goetzel. Interscience Publishers, Inc., New York. 898 pages. $22.

*Reviewed by C. L. Mantell*

Here we have the third volume of the treatise. The first covered technology of metal powders and their products. The second covered applied and physical powder metallurgy, industrial materials, the practical evaluation and theoretical analyses of the materials, products and processes.

The third volume is a classified and annotated bibliography with 5,535 numbered references to the literature and 6,330 references to patents. The literature survey is broken up into a number of sections covering the history, reviews and texts, the industrial, design and economic aspects, and the nomenclature in a general section; the production of powders by mechanical, physical, chemical, electrical, and miscellaneous processes, the methods and equipment for manufacturing specific compositions for metal, alloy, and compound powders, the properties and behaviors of these powders, their testing and control in manufacturing operations, in a second section; the powder processing methods and equipment including conditioning, pressing and briquetting, sintering, combinations thereof, extrusion, metal working and subsequent treatments in a third section; the powder metallurgy products such as those which are refractory or rare, the hard metal compositions such as the carbides, electrical contacts, electrodes, brushes, and materials for electronic application, the magnetic materials of the permanent and semipermanent type, the ferrous materials and products, the nonferrous alloys of copper, nickel, cobalt, aluminum, magnesium, the precious metals and the base metals of low melting point, porous products, those applied for frictional uses, dental alloys, jewelry, medallions, welding electrodes, heat generation agents, coatings on powders and powder products, and sundry uses, in a fourth section; and a fifth under the heading of Theoretical Discourses.

The patent literature bibliography is somewhat similar in type save that it is more closely subdivided as to methods of production of the powders, the metal and the nonmetal powders themselves, the processing methods and equipment, the compositions and manufacture, as well as the applications.

It would appear, as in the Vols. I and II, that very little if any of the information appearing in the literature to date has been overlooked or omitted. Cooperation has been received by the author from authorities in all the industrial countries of the world. For the many uses to which a specialized bibliography may be put, the volume fills a need.

### Admirable

PULP AND PAPER CHEMISTRY AND CHEMICAL TECHNOLOGY. By James P. Casey. Interscience Publishers, New York. 795 pages. $15.

*Reviewed by R. S. Aries*

The chemistry of papermaking has made tremendous strides during the last three decades, yet there has been no commensurate increase in our book literature on the subject. This book fills the gap in an admirable way. Prof. Casey, who was associated with the New York State College of Forestry, has given us a thorough, penetrating and critical analysis of pulp and paper chemistry, enriching our literature with a well documented compendium on the subject. His more recent work with the A. E. Staley Co. as well as the aid which he has received from a number of experts in the industry have no doubt left an imprint on the book.

Volume I deals with the basic aspects of cellulose and hemicellulose, lignin and pulpwood. The chemistry of all of the older and various of the newer and more unusual methods of pulping is treated in detail, including chapter on semichemical processes as well as the pulping of annual grasses. Chapters on bleaching, fiber preparation, sheet formation, sizing, wet strength, coloring, microbiology, aspects and water requirements follow. The contents of Vol. II, still to be published, will include properties of paper, printing and what may be a comprehensive treatment of resin addition.

Prof. Casey has made skillful use of the literature. While there is hardly a page without references, he has not overdone his citations, and in most cases has applied his critical analysis and basic knowledge of the subject. The book is fundamental in nature, yet it can hardly be called theoretical. It has been written for the chemically trained man rather than the business man who so often is the paper mill superintendent.

Congratulations are in order for this fine work done by the author and his collaborators. This work will be of value both as a textbook and reference for everybody working in the paper industries. Most of its sections can also be viewed as a fine treatment of applied colloid chemistry. Let us hope that other segments of the chemical process industries will have as patient and thorough workers as Prof. Casey who will enrich our technical literature with more books of its breadth and depth.

### For Pre-Meds

TOPICS IN PHYSICAL CHEMISTRY. Second edition. By W. Mansfield Clark, William & Wilkins Co., Baltimore. 777 pages. $10.

*Reviewed by F. C. Nachod*

When Dr. Clark brought out the first edition of this text in 1948 he was fully aware that it was "sufficiently unconventional to constitute a risk" for the publishers. Little must he or they have thought that the approach of "Topics" was so successful as to warrant a second edition in so short a time.

The over-all plan of the 30 chapters has been maintained and the changes generally are but minor additions and expansions. The refreshing essay-like style will gain many friends for Dr. Clark, not necessarily limited to premedical students. Particularly, teachers of introductory general or physical chemistry courses who have a high "mortality" rate during lecture or recitation period would benefit by using "Topics" as "tonics."

### Methods & Evaluation

LIGHT HYDROCARBON ANALYSIS. Ed. by O. W. Burke, Jr., C. E. Starr, Jr., and F. D. Tuemmler. Reinhold Publishing Corp., New York. 639 pages. $15.

*Reviewed by V. A. Kalichevsky*

The rapidly growing interest in commercial utilization of light petroleum hydrocarbons resulted in the development of many new analytical procedures which were withheld from

publication during the war. Selected information on this subject is collected in the present volume which includes also the postwar material and brings the summary up-to-date. The work was done under the auspices of the Butadiene Committee on Specifications and Methods of Analysis. The book is divided into nine chapters.

Chapter 1 on History and Function of the Committee on Butadiene Specifications and Methods of Analysis reviews the work of the committee.

Chapter 2 on Butadiene Production Processes presents a brief summary of commercial methods used in manufacturing butadiene.

Chapter 3 on Butadiene Specifications and Applicable Test Methods explains the purpose and need for the specifications accepted for the product.

Chapter 4 on Schemes of Analysis discusses general schemes applicable to the analysis of gas mixtures common to the petroleum industry.

Chapter 5 on Sampling and Handling of Light Hydrocarbons prepared by Martin Shepherd, U. S. Bureau of Standards, summarizes precautions to be observed in securing representative samples. No standardized procedures are recommended for sampling materials such as gases rich in gasoline hydrocarbon vapors under the plant conditions.

Chapter 6 on Safety Precautions for Handling Light Hydrocarbons discusses the hazards involved in sampling. No emphasis has been made on the danger of spontaneous explosions that may occur in handling butadiene concentrates.

Chapter 7 on Analytical Methods (363 pp.) is the heart of the book. The chapter contains 54 official test methods issued by the Office of Rubber Reserve with pertinent literature references. This is the largest collection of specific procedures for analysis of light hydrocarbons appearing under one cover. The ASTM method of presenting the information has been followed making the book an excellent manual indispensable to every laboratory engaged in the analysis of light hydrocarbons.

Chapter 8 on Preparation of Samples of Known Composition for Test Programs by J. W. Tooke refers to the technique which has been developed for cooperative work in testing samples of gases.

Chapter 9 on Evaluation of Accuracy and Precision of Methods discusses errors and limitations of the analytical procedures. The number of tables seems to be excessive particularly because their detailed analysis is omitted.

The book is a valuable addition to the branch of analytical chemistry concerned with testing light hydrocarbon mixtures and fills the existing gap in the available information on this subject. No well-equipped petroleum laboratory can afford to miss this book in its library.

**Tung Oil**

DAS HOLZOEL. By Ewald Fonrobert. Berliner Union, Stuttgart. 560 pages. DM86.

*Reviewed by M. Wulfinghoff*

This is the work of a specialist who has devoted most of his professional life to the study of tung oil, its origin, recovery, distribution, properties, chemistry, testing and applications.

The presentation is precise and systematic. A brief introduction gives the historical background. Botanical data are covered on 9 pages. Areas of growth are subdivided according to location: China, North and South America, Africa, Asia, Australia, and climatic prerequisities and effects of various local factors are pointed out. The following 25 pages deal with recovery methods, shipping and storage, commercial usages and standards, with particular reference to the Chinese product.

Chapter IV discusses physical and physiological properties, and chapter V deals with the chemical composition. Chapter VI presents, on 175 pages, chemical processes taking place in the formation of standoils and surface films, isomerization, polymerization, carbocyclic compounds, di-acids, ester conversion, and changes due to the presence of oxygen. Treated in detail are reactions with hydrogen, halogens, ozone, peroxides, sulphur and its compounds, $NH_3$, $NO_x$, HNO, and $HNO_2$, thiocyanates an elaeostearic compounds, urea, phenol, maleic acid and acroleine.

Tests are treated fully in chapter VII, and standard testing methods are reviewed and critically appraised.

Chapter VIII describes uses and limitations in certain lacquers (other than in paints), in the soap industry, in the resin and plastics fields, and in connection with paints.

A chapter on surrogates and substitutes follows. In addition to an author index (about 3,000 entries) and a subject index there is a list of patents (with approximately 1,000 entries).

Since much of the text is in fine print, the quantity of the information contained in this volume would in itself suffice to make it a valuable aid to users, manufacturers, researchers and laboratory men interested in the subject of tung oil.

**Further Advances**

HETEROCYCLIC COMPOUNDS. Edited by Robert C. Elderfield. Vol. 3 (442 pages; $12) and Vol. 4 (674 pages; $17). John Wiley and Sons, New York.

*Reviewed by Edgar A. Steck*

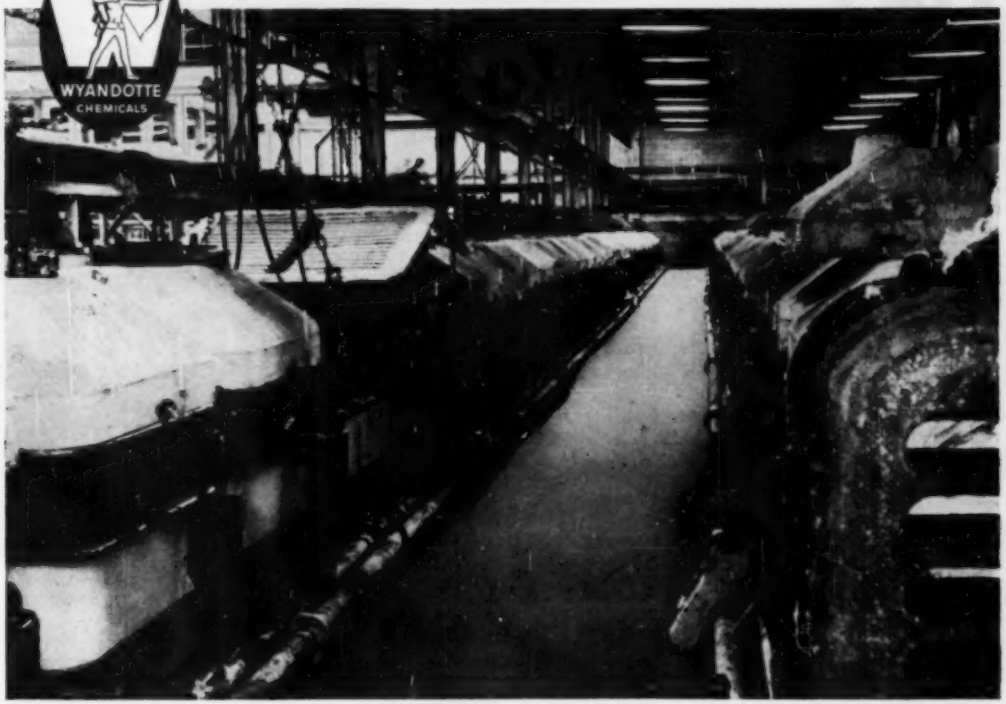
The two volumes at hand represent further advances in a well-established series on heterocyclics which give the user thorough discussions of certain of the numerous segments of the field. As in the past, the authors of the sections of the work have been chosen from the groups active in research. These two volumes were once intended as one, but the choice of two separate ones for consideration of the polycyclic types containing one nitrogen atom has permitted better handling for both authors and users. Each unit of the series further attests the care and balance in the planning which make certain of its elegance as well as value.

The total costs may be high, but the outlay is small for the information available.

Volume 3 of the compendium includes discussions on indole, isoindole, carbazole, pyrindine and related types, tropane and similar types having nitrogen bridges; Volume 4: quinoline, iso-quinoline, acridine, phenanthridine, and benzoquinoline types. These numerous units are handled with the same fundamental thorough pattern, but with sufficient individuality to keep healthy tension. The greater number of articles have been due to the efforts of individuals engaged in academic work, but there have been some contributions from industrial scientists, too, in these volumes. It is to the credit of all that the intertwining of importance of reactions and applications have not been neglected, even in some rather non-obvious connections. The patent literature has been handled with the care due it. The publishers have given much opportunity for the contributors to indulge in the use of many structural formulas, and hence the use is not tedious as it could be otherwise.

It is usually easy for one to criticize even the best of efforts. About this series, however, very few unfavorable comments can be made. The unsettled situation with respect to nomenclature in several of the ring systems must be considered at fault rather than use of non-C.A. methods here. It would still be helpful, however, to have some scheme (perhaps as on the backs of "Beilstein") for the ready indication of the scope that each volume covers.

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***Purecal:***
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| Census Data | Data on general characteristics of the manufacturing industries and on the value and quantity of products made and shipped. | "Annual Survey of Manufactures: 1949 and 1950." Supt. of Documents, Washington 25, D. C. $2. |
| Research | Manual and general description to help the Mutual Security Agency explain how industry does and uses research in the United States. 90 pages. | "Applied Research in the U. S." Publication 210. National Research Council, Washington 25, D. C. $1. |
| Toxicity | Current research and research needs in agricultural pesticides for the guidance of USDA investigators and for industry's information. | "Toxicity of Insecticides, Fungicides, and Herbicides." Agricultural Research Administration, Washington 25, D. C. |
| Steel Piping | Latest approved form of 56 widely used specifications for carbon-steel and alloy-steel pipe and tubing, including stainless. 384 pages. | 1952 edition. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $3.50. |
| Refractories | Standard and tentative specifications, classifications, test methods and definitions. 293 pages. | 1952 edition. American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa. $3. |



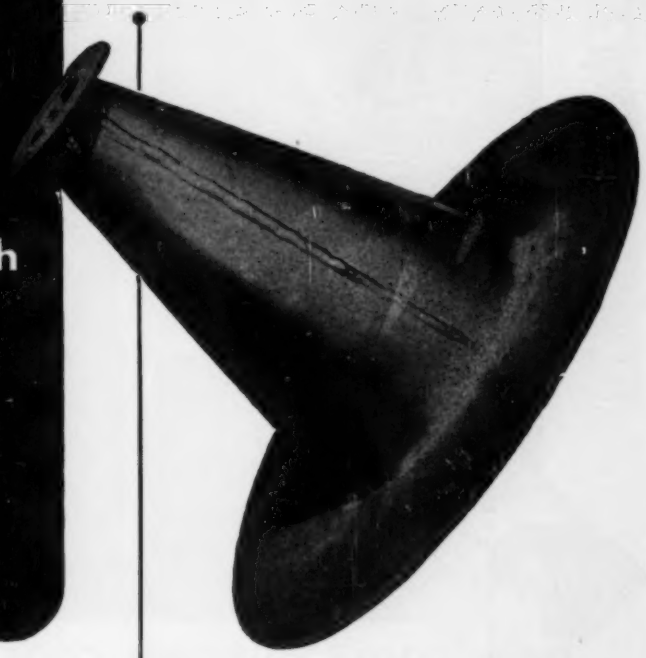


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**SEE PAGE 322**

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Handling a coagulating solution calls for pumps that need no excuses. If performance falters, even briefly, expensive troubles can result. And if the pumps are not metallurgically exact, there is the possibility of staining the end product with consequent destruction of value.

So this manufacturer turned to LaBour, because LaBour pumps have an unequalled reputation for staying on the job. Moreover, LaBour's nearly 30 years of experience in serving the chemical industry has created foundry methods that assure meticulous adherence to metallurgical specifications. The pumps in the picture are non-priming, and the hydraulic job (300 G.P.M. against a 70 foot head) isn't difficult, but this buyer wasn't willing to take a chance with anything less than a LaBour.

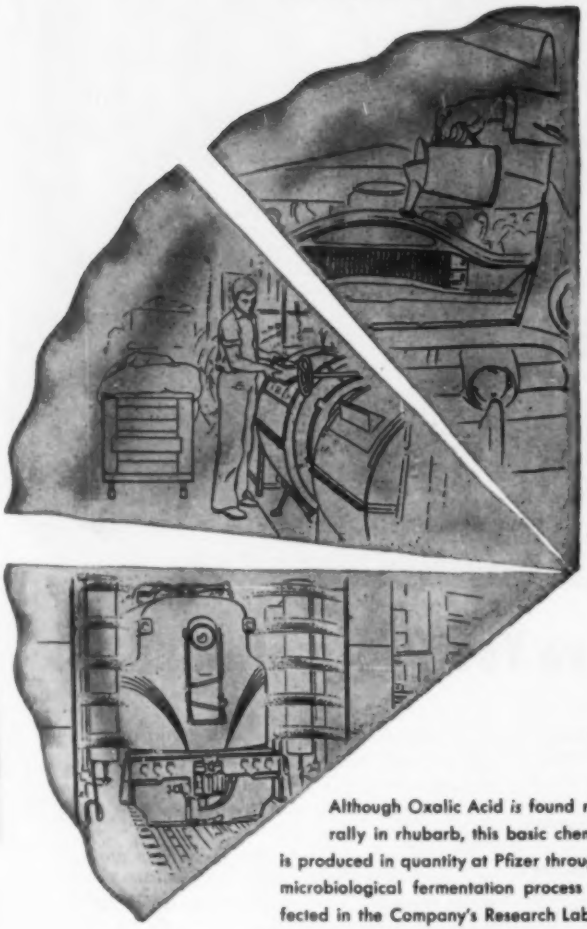
Can you afford to take chances on your pumping jobs? When you specify LaBour, there will be no grounds for anyone to question your judgment, no matter what happens. You'll get true pumping economy as well as peace of mind when you put LaBour's on the job.

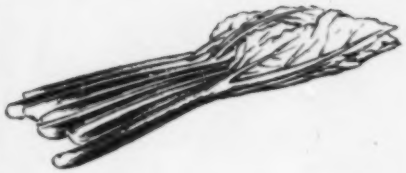
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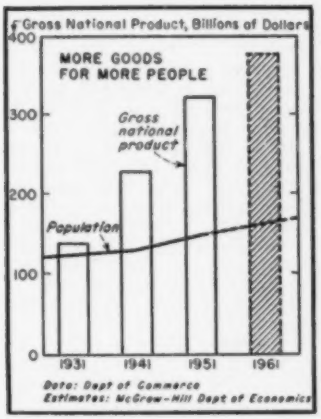
Because of its ability to solubilize iron oxide, Oxalic Acid is highly effective as an ingredient of metal cleaning compounds, in radiator flushes and as a rust remover in textile and leather processing. Its bleaching properties make it useful as a laundry sour and in the treatment of straw, cork and leather.

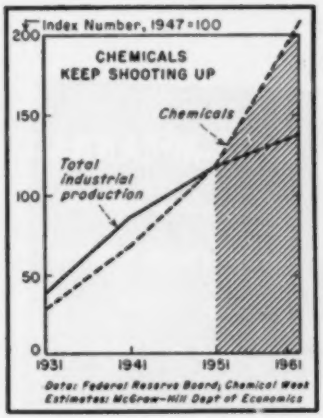
For more detailed information on the varied uses of this important organic acid, write for Technical Bulletin #34.

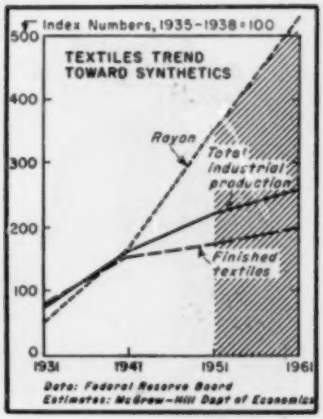
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Chemicals and allied industries promise to grow spectacularly in the next ten years. Their production trend is still shooting upward as new developments broaden the range of chemical products. Chemical production as measured by *Chemical Week's* output index may well gain 75 percent.

The great expansion is coming not in the old-line heavy chemicals, but in new specialty chemicals, and particularly in synthetic products to replace costly fibers, metals or other natural materials.

Synthetic fibers are growing at a rate that may double their markets by 1961. Orlon and Dacron will replace cotton and wool in a large variety of apparel uses. Nylon will go increasingly into industrial products.

Right now chemical plants are furnishing more than 20 percent of our textile fiber requirements. By 1961 close to 40 percent of the fibers consumed by U.S. textile mills is likely to be synthetic. Most natural fibers will be chemically treated to prevent shrinkage or wrinkling.

---

HOWARD C. GARY prepared this article from a detailed survey just made by McGraw-Hill's Department of Economics.

## What *Can* Happen by 2000

**If you've got a stake in what the chemical process industries can expect by 1980 or 2000, you don't want to miss the special forecast we'll publish next month. The job will be done by Dr. R. H. Ewell, well-known chemical economist at Stanford Research Institute.**

**Look for it in our July issue.**

---

Plastic materials are finding new applications every day. Production should top 6 billion-pounds per year by 1961, compared with 2.5 billion pounds in 1951. Molding materials to replace metal and wood, plastic sheetings, coatings and abrasives will all come into greater use.

A swelling stream of petrochemicals will come from refinery byproducts as the oil companies go further into this field. The industry is convinced that by 1961 up to 50 percent of all synthetic organic chemicals will be made from oil or natural gas. Recently the ratio was roughly 25 oil and 75 coal.

Production of the conventional refinery products will also rise steadily. The growing number of cars, trucks, planes and buses making longer trips with bigger loads means more gasoline. Much of it will be higher octane for use in new, high compression engines. Diesel use is also on a sharp upcurve. Refiners will produce more of these and less of the heavy heating fuels.

Drugs will be needed in larger quantities. Doctors will prescribe for more people than ever before, as both industry and government are increasing medical aid programs. Antibiotics reap the biggest benefits. But since the national level of medical care is rising, all types will gain.

Chemicals for the farm will help offset the higher cost of farm labor and gradual depletion of soil. Fertilizer, insecticides, and weed killers will be needed to raise crop yields per acre. There is a rising demand for new drugs to stimulate growth and reduce disease among livestock. Total consumption of chemicals in agriculture will be up a third or more if these trends continue until 1961.

### OVER-ALL GROWTH

Naturally, the economy as a whole cannot be expected to keep pace with chemicals, but the over-all situation will reveal substantial growth.

If we have no war, and if ten years from now we are enjoying reasonably full employment, statistics for 1961 should read something like this:

| | Billions | Gain Over 1951 |
|---|---|---|
| Total national output..... | $380 | 16% |
| Population (in millions)..... | 175 | 14% |
| Business capital expenditures | 37 | 17% |
| Consumer expenditures..... | 255 | 24% |
| Construction expenditures... | 50 | 20% |

These estimates are all in 1951

# If your process requires the valving of "hard-to-handle" fluids . . .

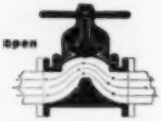


**HILLS-McCANNA**

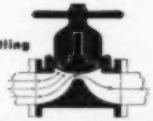
*Saunders Patent*

diaphragm valves provide the answer

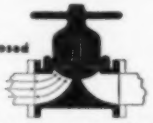
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prices. If we should have a strong inflation, the gross national product might be blown up considerably. But that would be simply a rise in prices. Our figures stand for a rise in the real output of goods and services.

### HOW GROWTH DETERMINED

General growth is determined by: (1) Growth of the population, and more specifically that share of the population which works; (2) Amount of time the labor force is at work; (3) Effectiveness with which the work is done—or productivity, usually defined in terms of output per man-hour.

Productivity is, in turn, determined mainly by: (1) The resources and tools used by the working force; (2) The skill and energy with which these tools are used.

Population growth is a key factor making for an expanding economy. More people require an increasing flow of goods and services. And an expanding population provides more workers to turn out the goods.

The growth of the U. S. population in the past decade has astounded all the experts. Observers attribute most of the gains to higher incomes. The feeling of greater economic security led people to marry earlier and to have more children. The march of medical science extended the life span.

Because of the low birthrate in the mid-30's there will be fewer people of marriageable age within the next decade. But continued progress in combating the diseases of old age are certain to assure continued population growth, although it will be less spectacular than that of the 40's.

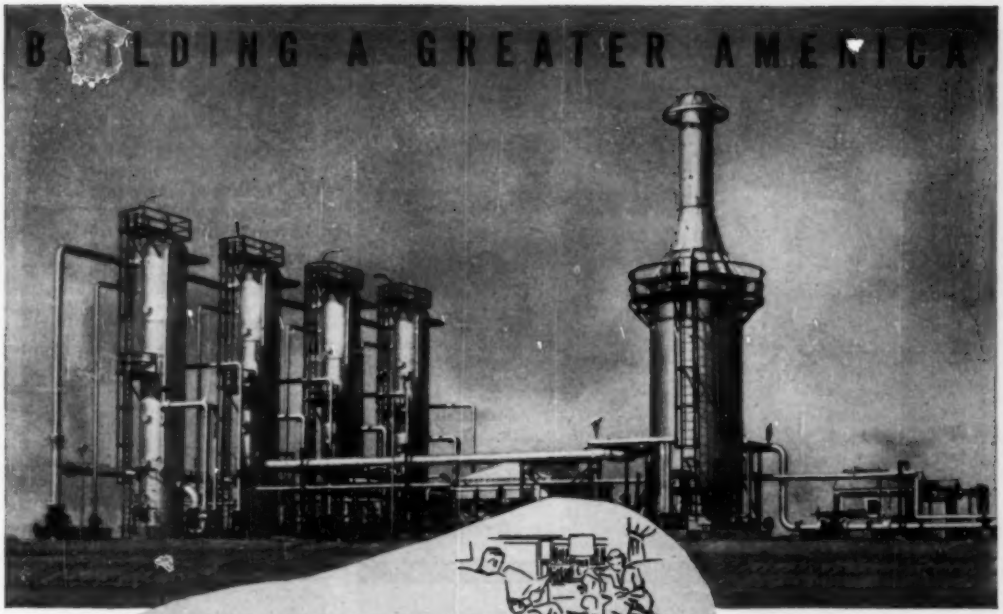
### LABOR AND WORK WEEK

The labor force will not rise as rapidly as total population. Again, the smaller baby crop of the 30's means fewer workers in the 50's. But the increasing role played by women in industry plus boosts in life expectancy clearly spell a rising labor force.

Counterbalancing the rising labor force will be the trend toward a shorter working week. In 1961 the work week will have fallen to 40 hr. from the present average of 44 hr. Farmers will tend to work more than 40 hr. while factory workers will put in less time. Hence a rise in national output will turn on increased effectiveness at work rather than more hours of labor.

### PRODUCTIVITY

Industry is constantly developing new machines and new methods to multiply the effectiveness of each worker. The accelerated tempo of in-




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# Across the wide Missouri

Pioneers in prairie schooners blazed a courageous trail "across the wide Missouri . . ." and across the entire continent . . . in their search for new opportunity.

The industrial services of modern America have followed in that trail. Thriving farms, towns and cities mark sites where pioneers found only hardship . . . because American industry is truly "All-American."

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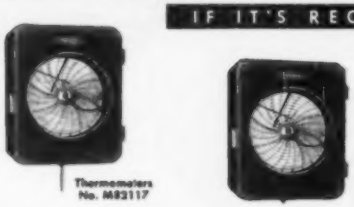


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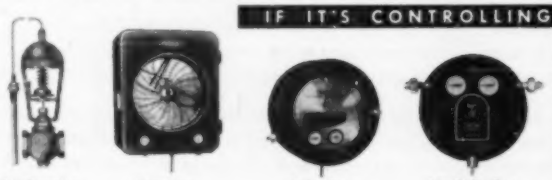


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dustrial research is ample evidence that this process will continue.

It is entirely conceivable that the U.S. economy may increase its productivity 3-5 percent a year for the next five years. The editors of *Factory* estimate that if the most modern equipment and the best methods were generally adopted, output per man-hour in manufacturing could rise more than 5 percent a year for ten years.

However, political and social considerations make it likely that actual results will be a bit short of the theoretical maximum. Corporate profits—the driving force behind industry modernization and expansion—are a favorite political target. And large labor unions seem more intent on getting a bigger slice of the pie rather than increasing the size of the pie.

It seems that the probable step-up in productivity over the next decade will be about 2 percent a year. This was the average annual increase over the years 1929-1950. The growth reported in this study is based on this 2 percent rise per annum.

### OTHER GROWTH INDUSTRIES

• **Electric Power** – The electric power industry has tremendous growth ahead. Industry observers expect industrial power sales to rise 50 percent and residential sales to more than double by 1961.

The growth industries—like chemicals—are among the greatest users of electric power. And throughout all industry, the amount of power per unit of production is growing. In 1951, industry used about 1 billion kwh. for every point of production on the Federal Reserve Board index. But by 1961, the ratio will probably be over 1.3 billion kwh.

It all adds up to the fact that electric utilities will have to double capacity by 1961.

• **Metalworking**–Metalworking industries are diverse. Some branches will expand more rapidly than total industrial production, others will lag somewhat. The major ones:

*Automobiles*—Prewar "normal" annual market of 3.5 million cars has been replaced by new "normal" of from 4.5 to 5.5 million. There may not be much growth ahead for the industry. But, on the other hand, much to everybody's surprise, industry output may well be sustained at the high 1951 level.

*Trucks*—This industry promises to grow. Trucks are competing effectively with railroads. New transportation demands—such as those arising from the growth of frozen foods and meats—call for the trucker's flexibility of service.

*Railway Equipment*—With all their competition, railroads are clearly not a growth industry. But in order to meet their competition the railroads will have to cut costs. New passenger and freight cars, diesel locomotives, the coal and oil-fired gas turbine locomotives now under development—come under the heading of new equipment that will be used to cut costs. So the output of railway equipment may continue at a level higher than before Korea.

*Farm Machinery*—Mechanization of U.S. farms is far from complete. The increased cost of hand labor is spurring the process. Government support of farm income will provide the income to buy the new equipment.

*Construction Machinery*—This industry is certain to grow more rapidly than total industrial production. Rising need for heavy construction and rising labor costs will put pressure on contractors to mechanize their operations.

• **Mineral Industries**—Like metalworking, the mining industries have widely varying growth prospects. Total output of minerals is likely to lag behind industrial production.

*Fuels*—Natural gas—for home heating and industrial purposes—will be the big gainer. From 1946 to 1951 natural gas sales almost doubled. And it appears that sales will again double or triple within a decade. But since total use of energy—for heat, light, power and transportation—is expected to rise more than 25 percent by 1961 the demand for coal and fuel oil is sure to increase, too.

*Metal Mining*—The light metals (such as aluminum, magnesium and titanium) promise to gain faster than the old standbys, such as copper and iron.

NOT A FORECAST

For the next ten years we have indicated: (1) The substantial growth potential for the economy as a whole; (2) The extraordinary potentials for growth of a number of individual industries and industrial fields.

But a statement of potentials is not a forecast of business conditions ten years hence. It is certain that the economy will continue to have its shares of ups and downs. And much will depend on how government, industry and labor react to the unfolding of events.

There is good reason to believe—and even more reason to hope—that this nation will have the tolerably wise political and economic leadership required to attain these potentials.

But the final answer on whether or not they will be attained is left for the future to tell.





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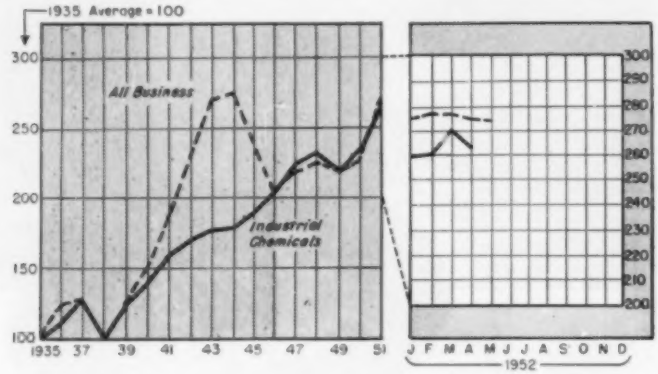
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# Process Industry Trends

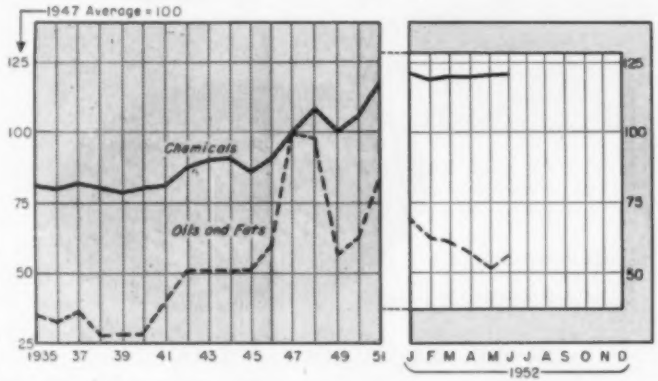
## CONSUMPTION




**Industrial Chemicals Index**

| | April (Est.) | Mar. (Prelim.) | Feb. (Revised) |
|---|---|---|---|
| INDEX | 264.90 | 271.46 | 260.81 |
| Fertilizers | | 66.10 | 62.10 |
| Pulp and paper | 28.92 | 30.49 | 29.06 |
| Petroleum refining | 22.11 | 26.73 | 24.91 |
| Iron and Steel | 14.64 | 17.25 | 15.88 |
| Rayon | 22.46 | 23.56 | 24.37 |
| Glass | | 21.78 | 20.65 |
| Paint and varnish | | 26.95 | 25.58 |
| Textiles | | 9.81 | 10.99 |
| Coal products | | 12.63 | 10.95 |
| Leather | | 4.89 | 4.33 |
| Explosives | | 8.33 | 8.68 |
| Rubber | 6.10 | 6.12 | 5.89 |
| Plastics | | 17.51 | 17.42 |

## PRICES

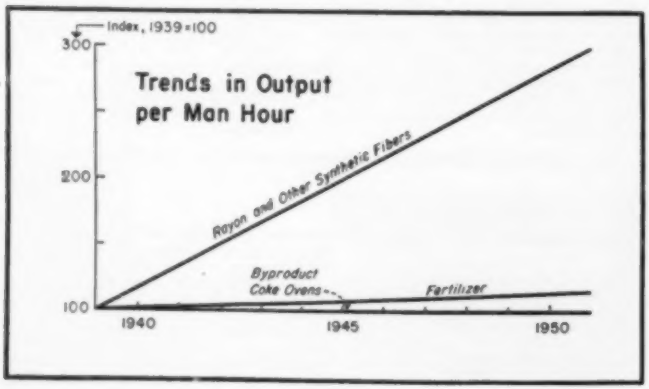



**Chemical Engineering's Price Indexes**

Chemicals UP +0.1%
Oils and Fats: UP +8.5%

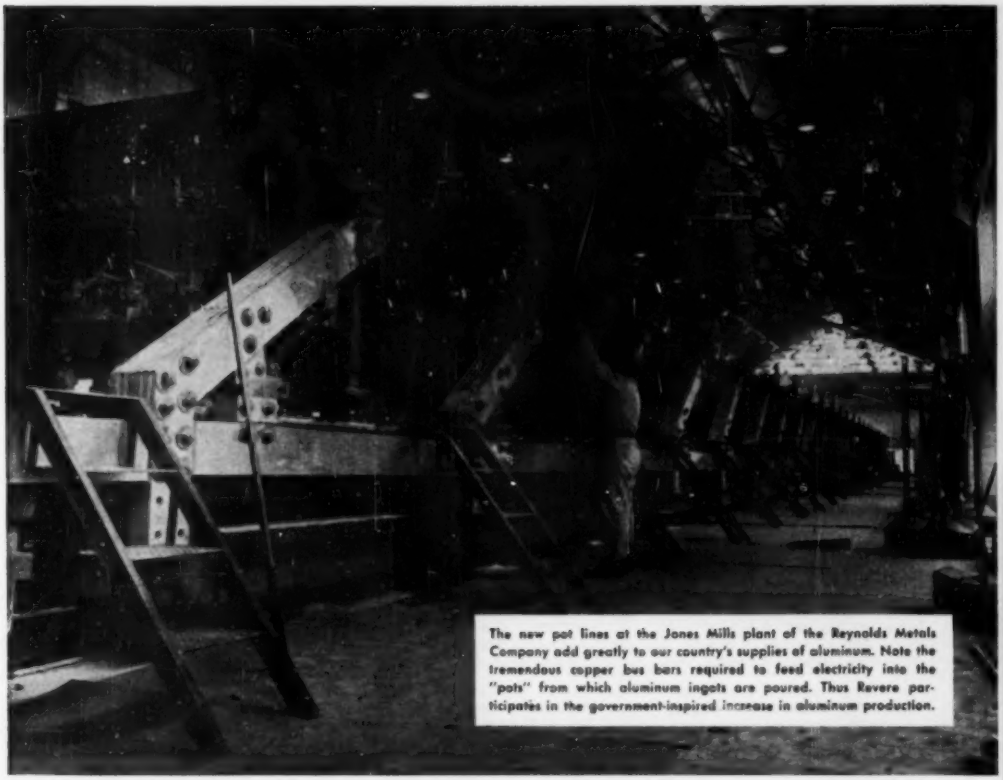
| | Chemicals | Oils & Fats |
|---|---|---|
| As of June 1, 1952 | 120.33 | 56.44 |
| Last month | 120.24 | 52.00 |
| June 1951 | 118.97 | 83.50 |
| June 1950 | 110.32 | 56.45 |

## HIGHLIGHT OF THE MONTH




### Output Up, Man Hours Down

Chemical industry rides a treadmill of obsolescence: you get nowhere if you coast. A case in point: man hours worked vs. productivity. The young industries are blessed with processes that lend themselves to automization—but they add good stewardship. Rayon and synthetic fibers, for instance, have swelled production by more than 250 percent in 12 years while man hours was up a scant 25 percent. Countercurrent to this trend are industries like byproduct coke and fertilizers. Output of the former went up 51 percent, manhours, 50, fertilizer per manhour up 28 percent.



The new pot lines at the Jones Mills plant of the Reynolds Metals Company add greatly to our country's supplies of aluminum. Note the tremendous copper bus bars required to feed electricity into the "pots" from which aluminum ingots are poured. Thus Revere participates in the government-inspired increase in aluminum production.

# It takes a lot of REVERE COPPER BUS BAR to increase aluminum production

● The Government has directed Revere to produce millions of pounds of copper bus bar for the new aluminum plants being put into operation in order to increase the output of this light metal that is so essential to defense. Copper is the ideal metal to carry the heavy currents required for the "pots" that produce aluminum from the ore. Thus aluminum and copper are intimately linked together. Aluminum is used in planes, ships, weapons, missiles, ammunition, and in many other defense applications. Copper, best of all the commercial metals in electrical conductivity, likewise has many vital tasks to perform for our armed forces, afloat, ashore, and in the air.

Revere is glad that its large capacity for the production of bus bar is so valuable in these times; in our long history of over 150 years of service we have always given everything possible in times of our country's need. However, we are regretful that today's government requirements materially limit our ability to fill civilian orders. We look ahead, eagerly and hopefully, to the time when the present urgent demands are met to such an extent that orders for bus bar and other Revere products can be filled more promptly.

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# New Construction

| | Current Projects | | Cumulative 1952 | |
|---|---|---|---|---|
| | Proposed Work | Contracts | Proposed Work | Contracts |
| New England | ..... | $150,000 | $6,000,000 | $2,357,000 |
| Middle Atlantic | $8,000,000 | 13,400,000 | 43,450,000 | 33,654,000 |
| South | 50,000,000 | 60,200,000 | 258,965,000 | 158,331,000 |
| Middle West | 4,000,000 | 39,505,000 | 35,330,000 | 107,363,000 |
| West of Mississippi | 67,154,000 | 3,251,000 | 460,847,000 | 223,022,000 |
| Far West | ..... | 200,000 | 9,728,000 | 24,540,000 |
| Canada | ..... | ..... | 180,833,000 | 35,938,000 |
| Total | $129,154,000 | $116,706,000 | $993,953,000 | $585,205,000 |

## Proposed Work

Ill., Plainfield—Hazel-Atlas Glass Co., 15th and Jacobs Sts., Wheeling, W. Va., plans to construct glass factory here. Estimated cost $4,000,000

La., Luling—Lion Oil Co., El Dorado, Kan., plans to construct chemical plant here, about 14 mi. north of New Orleans. Estimated cost $31,000,000

La., Pointe a LaHache—Sid Richardson, Fort Worth Natl. Bank Bldg., Fort Worth, Tex., plans to construct ammonia plant here, about 40 mi. S.E. of New Orleans. Estimated cost $19,000,000

Neb., LaPlatte—Allied Chemical & Dye Corp., 61 Bway., New York, N. Y., plans to construct a fertilizer plant. Estimated cost $25,000,000

N. J., Gibbstown—Hercules Powder Co., Delaware Trust Bldg., Wilmington, Del., plans to construct hydrocarbon chemicals plant. Estimated cost $8,000,000

Tex., Beaumont—Gulf States Utilities Co., Beaumont, plans to construct synthetic ammonia plant. Estimated cost $16,500,000

Tex., Beaumont—Magnolia Petroleum Co., Beaumont, plans to expand octane gasoline production refinery. Estimated cost $7,820,800

Tex., Freeport—Dow Chemical Co., Freeport, plans to construct additional electric power facilities. Estimated cost $15,833,300

N. M., Albuquerque—Malco Refineries, Inc., Roswell, N. M., plans to construct refinery. Estimated cost $2,000,000

## Contracts Awarded

Calif., Centerville—Viking Corp., Merchandise Mart Plaza, Chicago, Ill., has awarded the contract for a plastics manufacturing plant here to W. C. Tait, 2300 Mason St., San Francisco. Estimated cost $200,000

Del., Newark—E. I. du Pont de Nemours & Co., Inc., du Pont Bldg., Wilmington, will construct Haskell Laboratory for Industrial Toxicology here. Work will be done with own forces. Estimated cost $2,000,000

Fla., Fort Lauderdale—Florida Petro Chemical Corp., c/o Petrocarbon Equipment, Inc., 30 Vesey St., New York 7, N. Y. will construct a fuel gas and chemical plant near here. Work will be done with separate contracts. Estimated cost $6,000,000

Fla., Miami—Ojus Tile Co. c/o D. H. Reynolds, Inc., contractor, 306 Biral Rd., Coral Gables, Fla., will construct a tile manufacturing plant. Estimated cost $100,000

Ga., Albany—Merck & Co., Rahway, N. J., has awarded the contract for a warehouse to A. C. Sanford, Inc., P. O. Box 1229, Albany. Estimated cost will exceed $500,000

Ill., Calumet City—Catalin Corp., of America, 1 Park Ave., New York, N. Y., has awarded the contract for a polystrene plant to Blaw-Knox Construction Co., 930 Duquesne Way, Pittsburgh, Pa. Estimated cost $125,000

Ill., Chicago—Allied Chemical & Dye Corp., Barrett Div., 40 Rector St., New York, N. Y., has awarded the contract for a chemical plant at 130th St. and Grand Calumet River, to John Griffith & Son, 228 North LaSalle St. Estimated cost $30,000,000

Ill., Chicago—Interchemical Corp., 3030 West 51st St., has awarded the contract for a factory addition to Enger Bros., 4910 St. Paul St. Estimated cost $180,000

Ill., Chicago—Kentile, Inc., 4532 South Kolin St., has awarded the contract for a warehouse to Poirot Construction Co., 2001 Pershing Rd. Estimated cost $500,000

Ill., Chicago—Sherwin-Williams Co., 115th St. and Cottage Grove Ave., has awarded the contract for a laboratory to R. Gatwood, 5601 West North St. Estimated cost $100,000

Ind., Huntington — Asbestos Manufacturing Co., Div. of Thermoid Co., Trenton, N. J., has awarded the contract for a 2 story factory to Ragner-Benson Co., Inc., 4744 West Rice St., Chicago, Ill. Estimated cost $1,100,000

Ind., Kingsbury—Kingsbury & Co., 3001 North Emerson Ave., Indianapolis, has awarded the general contract for a fertilizer plant and warehouse to A. J. Sachett & Sons, 1701 South Highland Ave., Baltimore, Md. Estimated cost $500,000

Ky., Louisville—Cochran Foil Co., 1430 South 13th St., has awarded the contract for a plant addition to Sullivan & Conzart, Inc., 822 W. Kentucky St. Estimated cost $100,000

Ky., Louisville—Stauffer Chemical Co., 420 Lexington Ave., New York, N. Y., will construct a plant for the manufacture of carbon tetra chloride. Work will be done with separate contracts. Estimated cost $2,500,000

La., New Orleans—American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y., has awarded the contract for a plant to recover chemicals from natural gas to J. A. Jones Construction Co., 209 West 4th St., Charlotte, N. C. Estimated cost $50,000,000

Mass., Allston—Robinson Clay Products Co., 138 Brighton Ave., has awarded the contract for a warehouse and office to John R. Clark & Assoc., Inc., 73 Main St., Cambridge, Mass. Estimated cost $150,000

Mich., Montague—Hooker Electrochemical Co., 1940 Ward St., Niagara Falls, N. Y., has awarded the contract for a plant here to H. K. Ferguson Co., 1783 East 11th St., Cleveland, O. Estimated cost $7,000,000

Neb., Omaha—Manhattan Soap Co., Bristol, Pa., has awarded the contract for an addition to Haskins Bros. soap factory at 115 Hickory St., to A. Borchman Sons Co., 4601 Douglas St. Estimated cost $185,000

N. J., Vineland—Kimble Class Div. of Owens-Illinois Glass Co., Toledo, O., has awarded the contract for a plant here to Hughes-Foulkrod Co., 809 Schaff Bldg., Philadelphia, Pa. Estimated cost $500,000

N. Y., Syracuse—Bristol Laboratories, Inc., Thompson Rd., Syracuse, N. Y., has awarded the contract for a 4 story engineering and administration building to W. E. O'Neil Construction Co., 2751 Claybourn St., Chicago, Ill. Estimated cost $650,000

Pa., Philadelphia—Atlantic Refining Co., 260 South Broad St., has awarded the contract for a plant and filter building to Lauter Construction Co., 112 South 16th St. Estimated cost $250,000

Pa., Philadelphia—Barrett Div. of Allied Chemical & Dye Corp., Margaret and Bermuda Sts., will construct additions to its plant. Work will be done by separate contracts under supervision of Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., Engrs. Estimated cost $10,000,000

Tenn., Knoxville—Electro Manganese Corp., Proctor St., N. W., has awarded the contract for plant additions to V. L. Nicholson Co., 611 South Central St. Estimated cost $800,000

Tenn., Memphis—Velsicol Corp., 330 East Grand Ave., Chicago, Ill., has awarded the contract for a warehouse and shop to Sam P. Maury Construction Co., 554 Adams St., Memphis. Estimated cost $100,000

Tenn., Memphis—Virginia-Carolina Chemical Corp., Poplar St., has awarded the contract for a warehouse to E. W. G. Meers, 166 Monroe Ave. Estimated cost $100,000

Tex., Dallas—Diamond Alkali Co., Box 6140, has awarded the contract for a plant addition to E. E. Farrow, 6109 Forest Park Rd. Estimated cost $541,000

Tex., Deer Park—Diamond Alkali Co., Deer Park, will construct a perchlorethylyne plant unit here. Work will be done by owners. Estimated cost $750,000

Tex., Texas City—Republic Oil Refining Co., Texas City, has awarded the contract for a platforming refinery unit to have a daily capacity of 6,500 bbl. to Procon, Inc., 75 East Jackson Blvd., Chicago, Ill. Estimated cost $1,775,000

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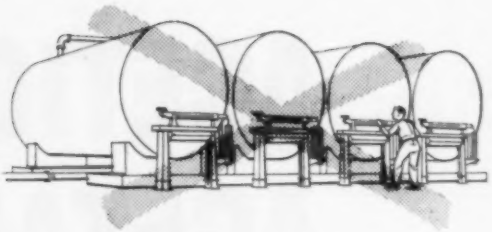
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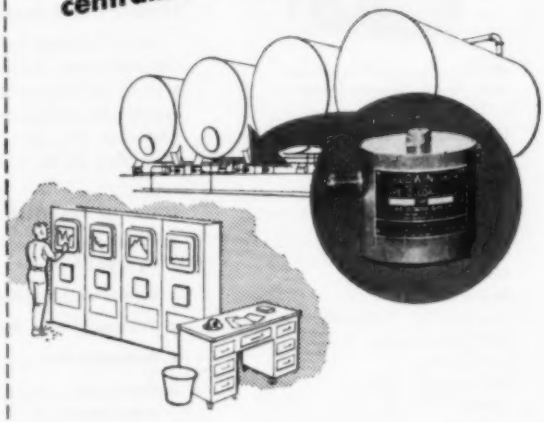
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# Reducing Galvanic Corrosion Attack in Sea Water

When two dissimilar metals are brought into electrical contact in an electrolyte, corrosion of the less noble metal (anode) occurs in excess of its normal rates in that electrolyte while the more noble metal (cathode) is protected. This accelerated corrosion is known as galvanic corrosion.

Galvanic action does not occur when dry dissimilar metals are in contact. It is for this reason that iron hangers can be used to support copper and brass pipe. Also numerous mechanical devices made of several dissimilar metals may be successfully used in the absence of water.

### Galvanic Corrosion in Salt Water

Solutions of chloride salts are recognized as being very corrosive towards the common metals and alloys and are found in (1) sea water; (2) salt refining; (3) in the manufacture of chlorine, chemicals, soaps, etc.; (4) cooling brines; (5) vegetable sorting brines; (6) crude oil and petroleum products and in numerous other places. Since salt water is so widely used in industrial operations, galvanic corrosion is commonplace because most equipment is generally constructed from many dissimilar metals and alloys.

### Galvanic Series Varies With Corrosive Environment

Information obtained on a group of metals, examined under a given set of conditions makes it possible to arrange the metals in a galvanic series.

The following table, showing the differences in behavior of eleven metals in sea water as compared with the Electromotive Series, was obtained by arranging these metals according to their potentials in solutions of their own ions.

| Galvanic Series in Sea Water | Electromotive Series |
|---|---|
| Magnesium | Magnesium |
| Zinc | Aluminum |
| Aluminum | Zinc |
| Cadmium | Iron |
| Iron | Cadmium |
| Lead | Nickel |
| Tin | Tin |
| Nickel | Lead |
| Copper | Copper |
| Silver | Silver |
| Gold | Gold |

However, they do not always follow the same order as given in the Electromotive Series generally published. The order frequently changes very markedly with the corrosive environment.

### Galvanic Protection of Copper-base Alloys

Plates of aluminum-base alloys, both with and without copper-base alloy bolts, were immersed in sea water. Within a few months the aluminum showed very slight general corrosion and more intense corrosion localized around the bolts. A similar test, conducted with zinc plates, gave practically the same results. Prolonging the latter test eventually led to a depth of attack sufficient to allow the copper alloy bolts to drop out of the zinc plates. In both instances the copper-base alloys remained intact and showed no signs of corrosion because they had been galvanically protected at the expense of the less noble metals.

### Cathodic or Galvanic Protection

Numerous investigations have shown that cathodic protection of metals is feasible. In practice this is accomplished, for example, by the sacrificial protection of iron by zinc, such as galvanized iron (galvanic) or by an imposed potential (cathodic protection) whereby corroding metal is maintained artificially as the cathode. This is applicable only to certain types of structures such as storage tanks, condenser water boxes and the exterior surfaces of pipe lines. This must be done with caution since certain metals may under some conditions be corroded more rapidly by the alkali which normally forms in the cathodic area.

### Satisfactory Galvanic Couples

The extremes in potential differences between various copper-base alloys in sea water and in 3% sodium chloride solutions is small, seldom exceeding 0.2 volts. Consequently copper and various copper alloys can be successfully coupled together in such corrosive media. This explains why they are so widely used in salt water services.

The potential difference between dissimilar metals may be unimportant due to the smallness of the exposed area of the more noble member of the galvanic couple. For example, copper alloy bolts fastened in steel plates immersed in sea water do not necessarily lead to increased corrosion of the steel. In such a galvanic couple, the *initial* potential difference between copper and low carbon steel may range from 0.5 to 0.7 volts. This lack of activity is due to stifling of the cathodic reaction on the relatively small surface of the copper alloy bolt head and nut. The stifling is due primarily to deposition of magnesium and calcium carbonate from the sea water on the cathodic surface (copper alloy). This explains why the widespread use of bronze bolts to fasten steel or cast iron parts in marine services has led to no difficulty from galvanic corrosion.

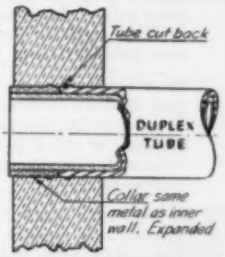



Fig. 1. A common method of protecting Duplex tubing from galvanic corrosion.

Silicon bronze bolts and brazed joints used to fasten together carbon steel sections exposed to sea water have led to no measurable increase in corrosion of the steel because of their small area compared to relatively large carbon steel sections.

### Protecting Duplex Tubing

Since Duplex tubes are often made from a combination of steel or aluminum with copper or a copper-base alloy, the problem of galvanic attack between the two different metals, in certain corrosive environments, can be solved in several ways.

Where it is necessary to prevent galvanic action at the tube sheet, a ferrule of the same material as the inside of the Duplex tube is used. One method is shown in Fig. 1.

Consult the Bridgeport Corrosion Laboratory for assistance with your galvanic corrosion problems on condenser and heat exchanger tubing for power refining or process industries.

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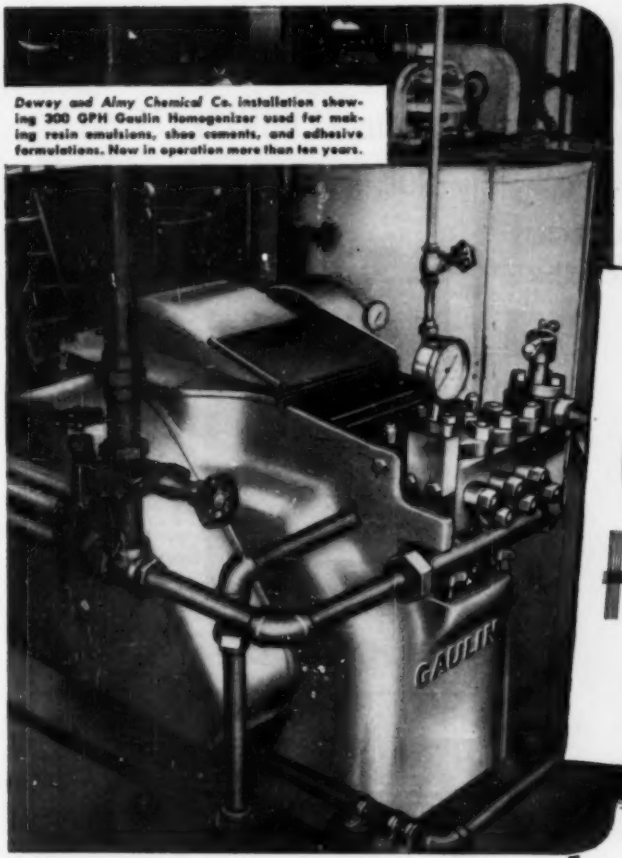
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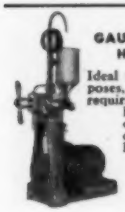
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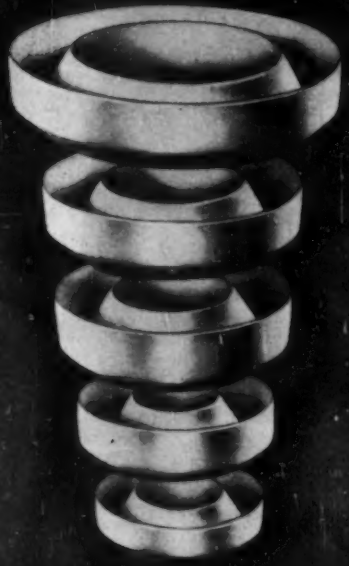
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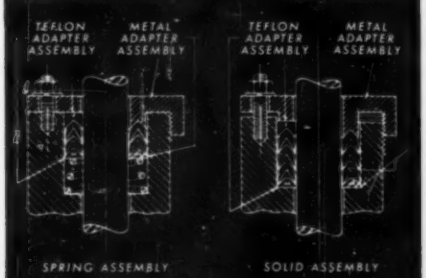



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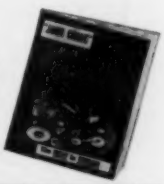
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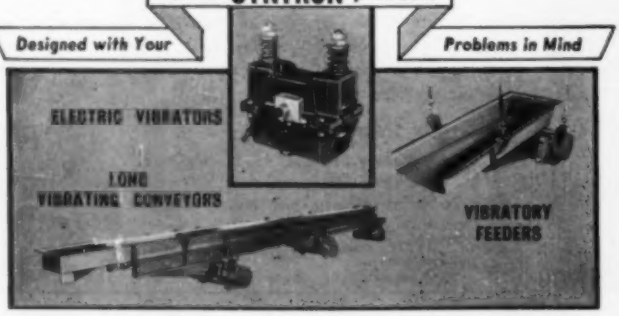
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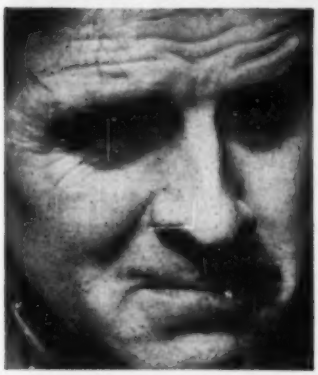
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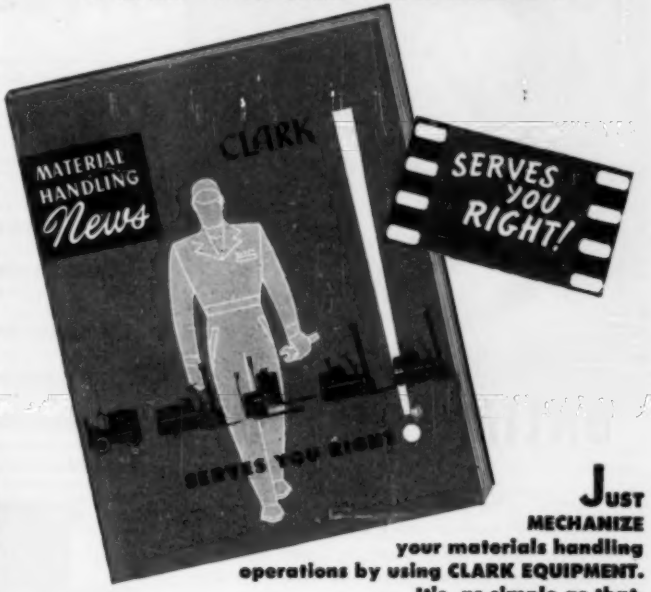
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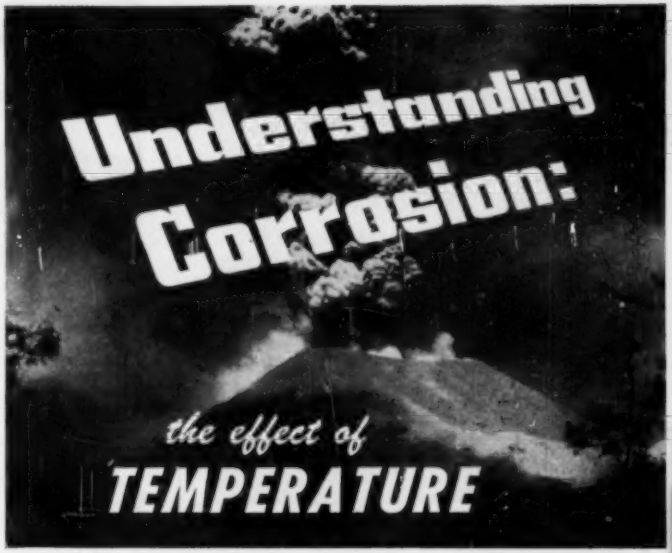
Search *your* plant for this idle metal . . . work with your local scrap dealer to increase supplies of badly-needed iron and steel scrap.

**What to look for . . .**

obsolete machines, tools and equipment, no-longer-used jigs and fixtures, worn-out or broken chains, wheels, pulleys, gears, pipe, tanks, drums and abandoned metal structures. Non-ferrous is needed, too!



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Temperature exerts a large influence as a determinant of the corrosion rate of metal, with the nature of the metal and its environment, and the degree of temperature and duration of exposure operating as governing factors. It does so primarily by influencing the variables that determine the supply of dissolved oxygen at the metal surface. In closed water systems from which oxygen cannot escape, weight loss approximately *doubles* for every 60°F. rise in temperature. In open systems, despite a decrease in oxygen concentration, the corrosion rate likewise increases rapidly with temperature because of the speed-up of oxygen transfer to the metal, the maximum being reached at about 175°F. and decreasing thereafter to practically zero at the boiling point. In acid solutions, temperature rise also markedly accelerates corrosion while in alkali solutions, on the other hand, a comparable increase generally has a retarding effect, with the concentration of the alkali a determining factor.

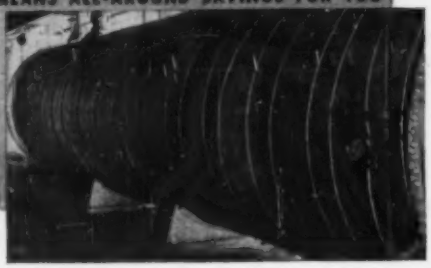
Among other effects are greater localization of corrosion as temperature raises electrical conductivity of electrolytes, increased pitting as hotter metal becomes anodic to cooler, and less natural protection as temperature alters physical nature of corrosion products — effects that further establish temperature as a factor to be thoroughly explored in assessing any corrosion problem.

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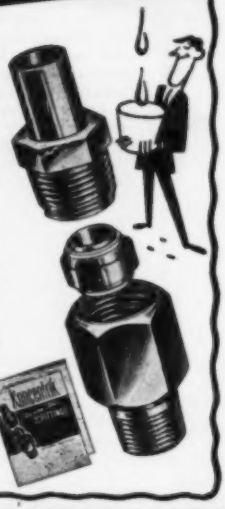
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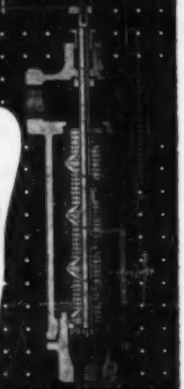
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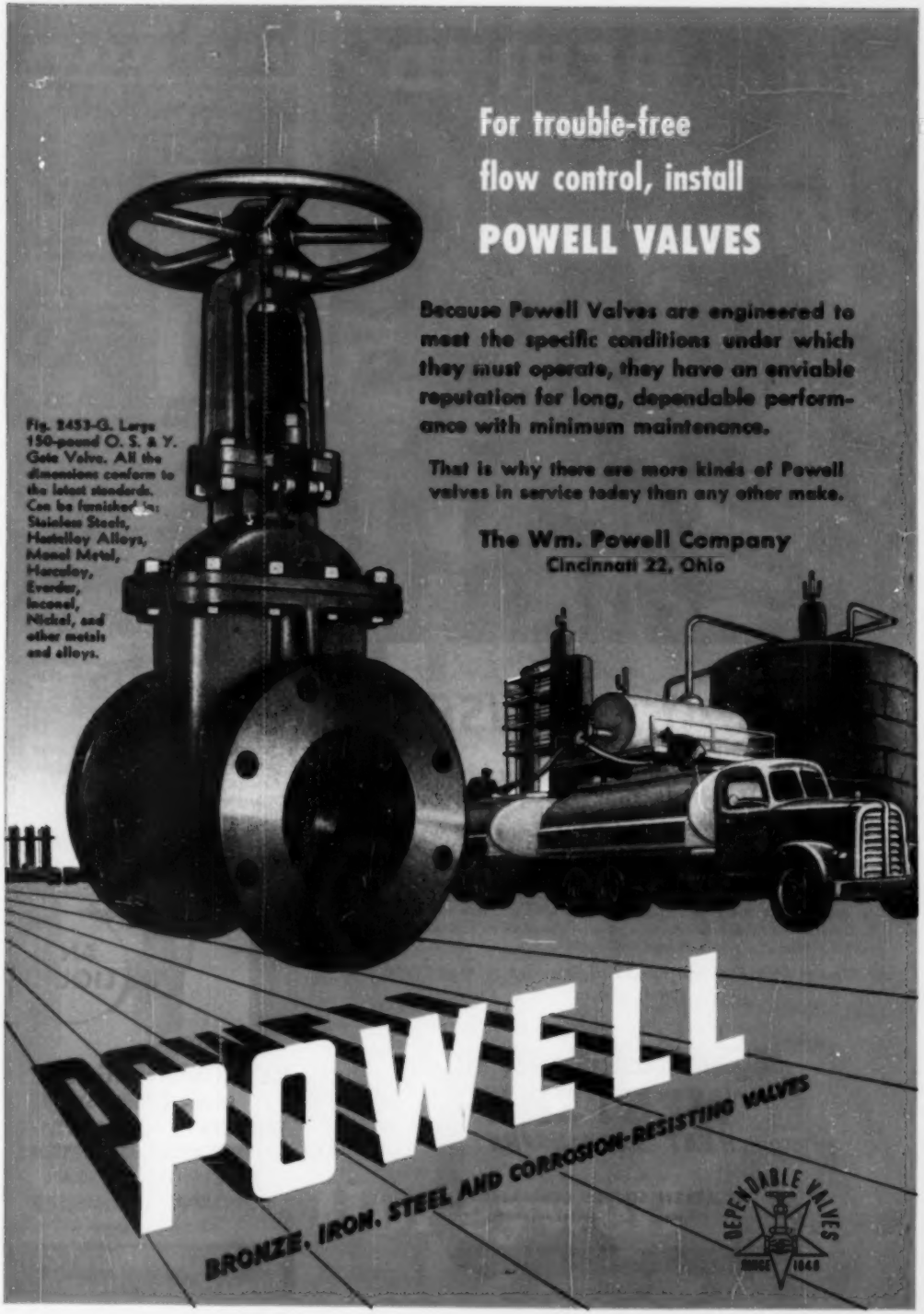
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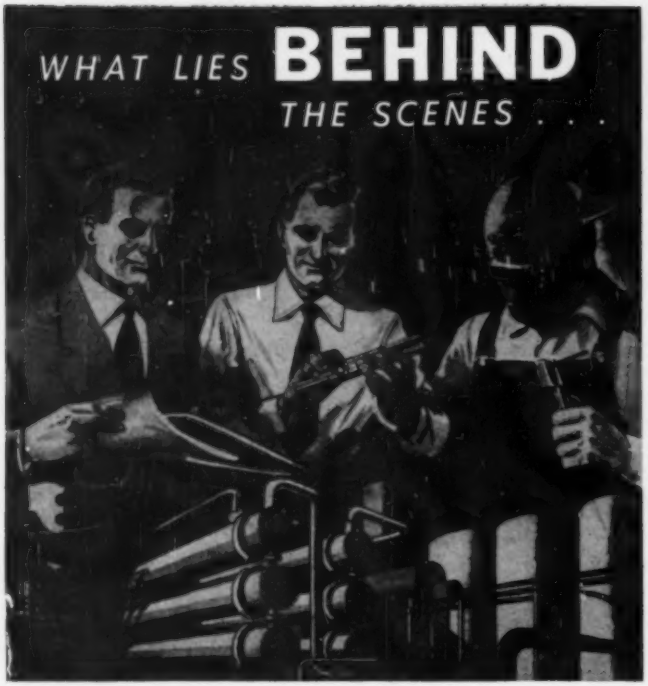
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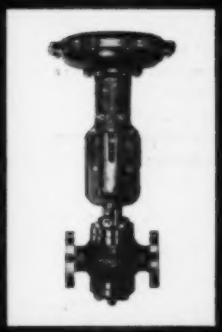
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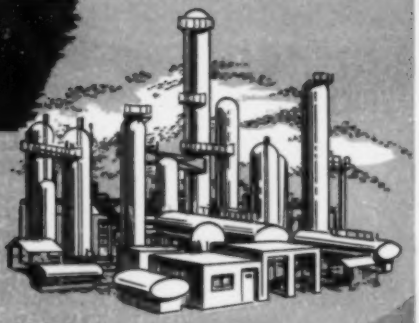
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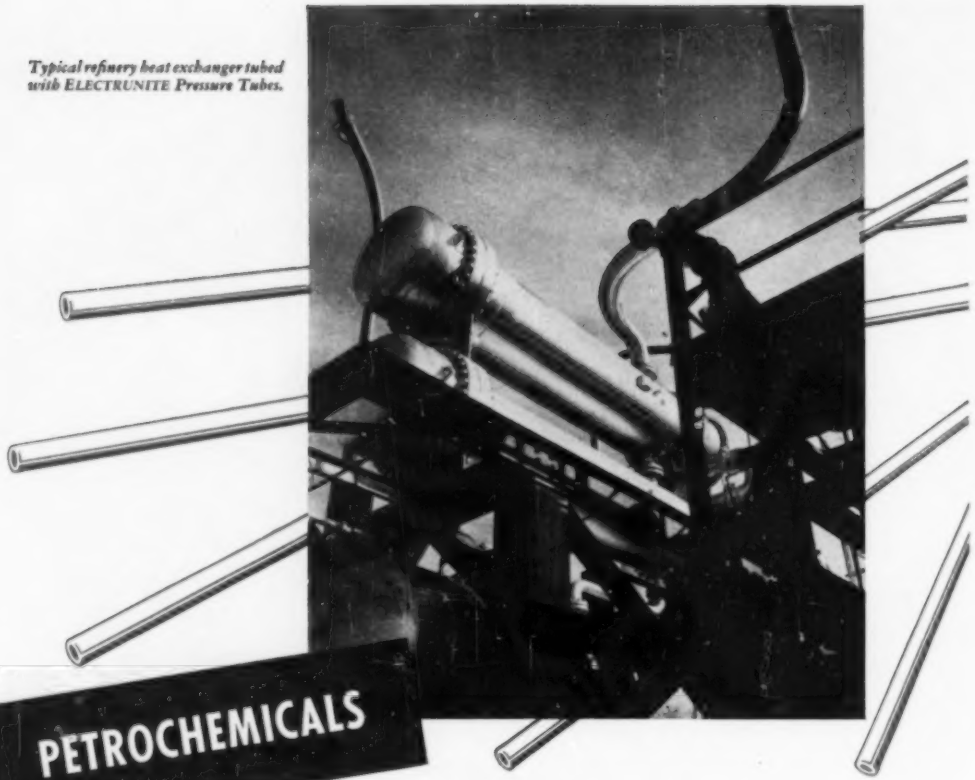





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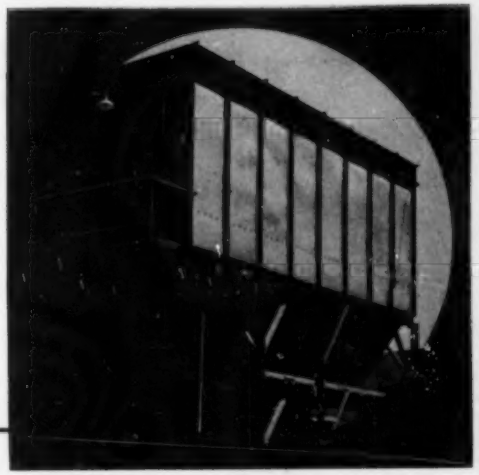
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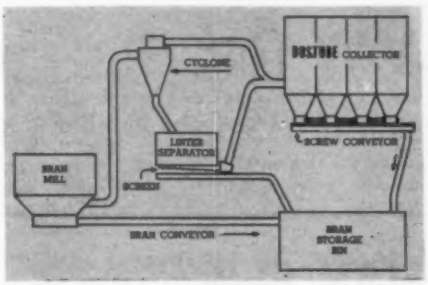
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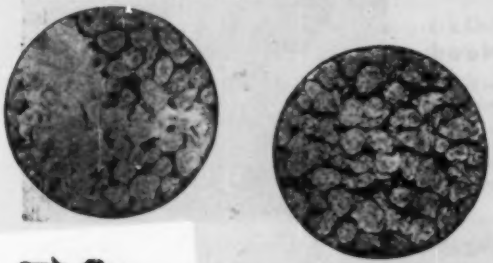
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That's why Simpson Mix-Mullers have proved superior in the Chemical Process Industries. By combining the chemist's mulling action with *large capacity, accuracy, speed* and *uniformity,* Simpson Mix-Mullers are able to meet every production requirement for blending dry, semi-dry or pasty materials. Thousands of installations offer positive proof of superior mixing results.

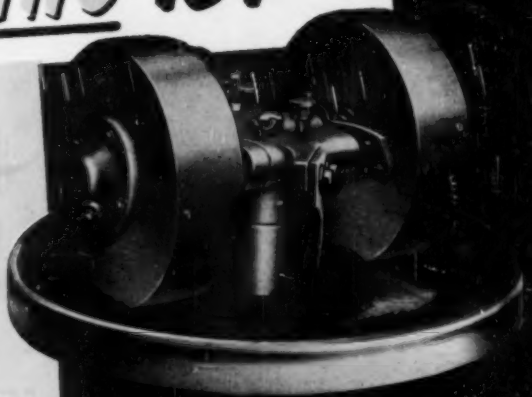
Mulling with a Simpson Mix-Muller utilizes a special pair of revolving mullers and plows mounted on a stationary pan. The mullers are adjustable and are supported by rocker arms so that they can be free to ride on the material, creating a true mulling action as they revolve. This eliminates all balling of material and quickly develops a maximum plasticity of the mix.

## . . . what SIMPSON Mix-Mullers can do for your process . . .

**You need only to look at the two photomicrographs below to realize the superiority of mulling in a Simpson Mix-Muller. At the left is result of using an ordinary paddle type mixer (note smear of unmixed material) — at the right the obviously finer, uniform results of using a Simpson Mix-Muller.**







View of laboratory size Simpson Mix-Muller with crib removed to show action of mullers. Note muller path in material.

*Here is why SIMPSON Mix-Mullers are used throughout the Chemical Process Industries:*

- GREATER PRODUCT UNIFORMITY
- FASTER MIXING CYCLE
- LOWER COST PER TON OF MATERIAL
- LESS LABOR REQUIRED
- LESS HORSEPOWER REQUIRED
- SAFER OPERATION

Simpson Mix-Mullers are built in capacities from 1/10 to 30 cu. ft. They may be specially equipped for heating and cooling while mixing—for mulling under vacuum or pressure—for corrosive materials—or to function as a reaction vessel.

FOR PROOF of the ability of Simpson Mix-Mullers to do a better job in mulling your material, our complete laboratory facilities are available without obligation . . . and if your material *can't* be successfully mulled, we'll tell you why. Write for complete details.



**SIMPSON Mix-Muller® Division**

**NATIONAL ENGINEERING CO.** 604 Machinery Hall Bldg., Chicago 6, Ill.

# You'll find them only in the

# JOY WG-9 COMPRESSOR



## These Exclusive Features are worth Money to you!

Only the JOY WG-9, in its class, offers replaceable crosshead guides and cylinder liners, and full force-feed lubrication—features that will save you money in operating and maintenance costs. Unique truncated pistons and angled over-size "Dual-Cushion" valves assure higher valve capacity, better heat dissipation, lower air friction and elimination of valve pounding.

The WG-9 is a water cooled, double acting, single stage, heavy duty compressor for use where medium amounts of air are needed or for supplementary service in high air-requirement industries. Vertical design minimizes vibration and cuts required floor space. Foundation is but a simple concrete pad.

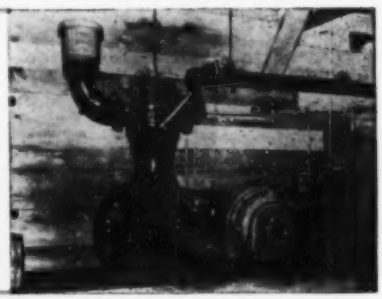
**15 SIZES • 30 to 150 lbs. psi • 172 to 881 CFM**

*Consult a Joy Engineer*



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High and low pressure compressors, oil free compressors, boosters and vacuum pumps—Joy builds a type and size for every need. • Let us handle *your* air-supply job.



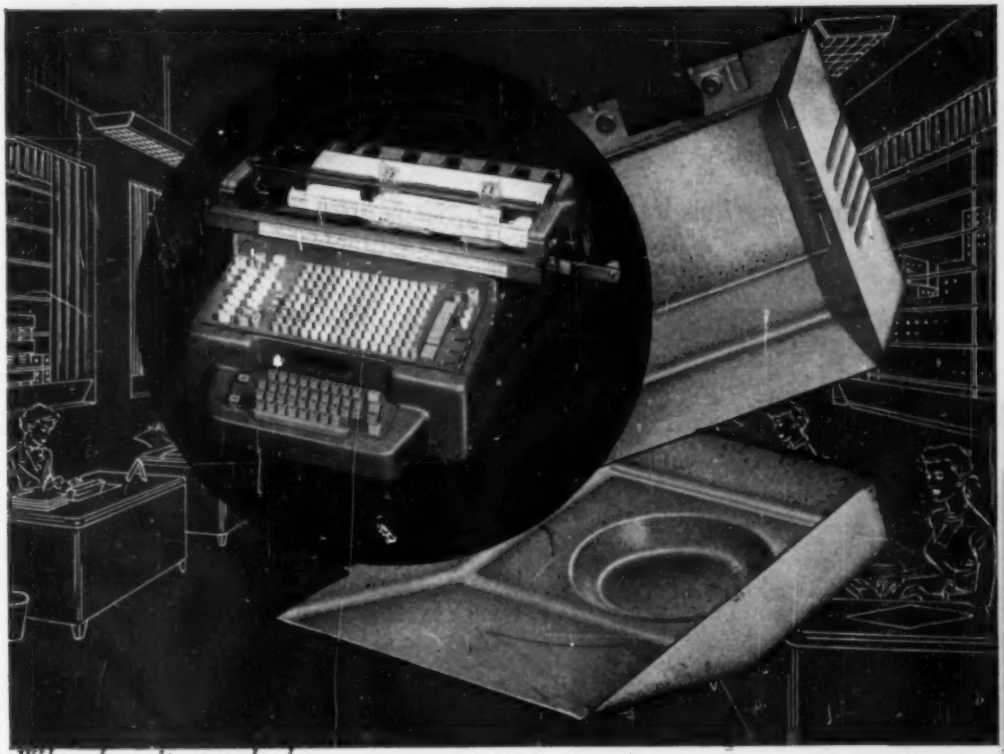
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*Why doesn't somebody...*

# build better machine housings?

**Somebody does!** With a remarkable new plastic material—Vibrin polyester resin. Look what it's done for one of the products of the National Cash Register Company.

Used for several housing parts on their Class "31" Accounting Machines, this glass-fiber-reinforced Vibrin* gives far superior sound-deadening effects. And what an unusual combination of lightness and toughness! These handsome molded pieces have all the ruggedness, the oil and shock resistance to take the hardest use for as long as the machine lives.

*These Vibrin parts not only did the job—they did it better than the material previously used!* To National Cash Register, as to other great manufacturing leaders, Vibrin has provided the basic material on which important product progress is being built.

Versatile Vibrin is just another example of Naugatuck's ingenuity and imagination at work, solving old problems, creating new products. Chances are Naugatuck Chemical can help you to a better product. Why not send us the coupon below?

. . .

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Without charge, send technical data for these end uses:

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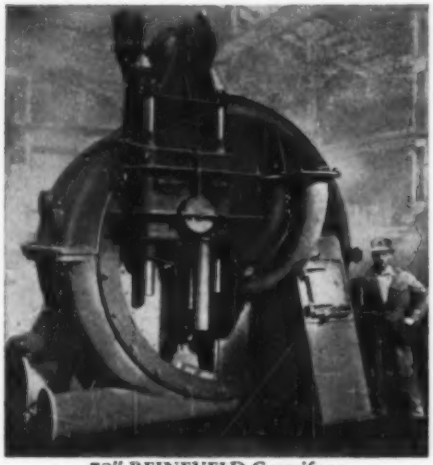
COMPANY _____

ADDRESS _____

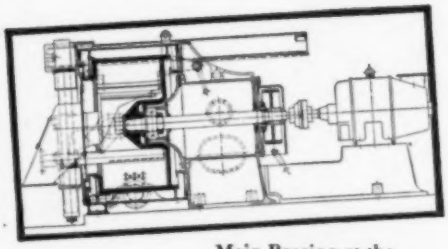
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# The International REINEVELD Centrifugals

## Are Now Available in the United States and Canada through *Heyl & Patterson*



79" REINEVELD Centrifuge



Main Bearing at the Center of Gravity

### REINEVELD'S Patented Design *Guarantees*

**Greater Production** **Lower Impurities**
**Drier Product** **Lower Maintenance**

**Advantages of Reineveld Centrifugals**

1. Freedom from Vibration
2. Large Capacity
3. More Cycles per Hour
4. Simple, Rugged Construction
5. Low Maintenance

***For Complete Information on Reineveld Centrifugals . . . Write for Booklet 4-RC-2***

Reineveld Centrifuges, Separators and Classifiers . . . manufactured by Reineveld Engineering Works, Delft, Holland . . . can now be obtained through the agency of Heyl & Patterson.

Reineveld machines have widespread applications in the Chemical Processing Industries because of their outstanding processing and mechanical advantages.

Reineveld's patented design features the main bearing at the center of gravity of the rotating mass. This outstanding feature allows a higher safe rotating speed and freedom from vibration. The exclusive Reineveld processing method makes possible the formation of a superior, fast-draining filter bed.

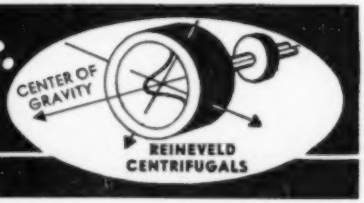
Reineveld Centrifugals range in size from 36" to 79" drum diameter. In any size machine Reineveld Centrifugals give Greater Production . . . Drier Product . . . Lower Impurities . . . Lower Maintenance.

Heyl & Patterson laboratory facilities are at your service to test your material and recommend an economical and guaranteed application.

## Heyl+Patterson, Inc.

"SINCE 1887"

55 WATER STREET · PITTSBURGH 22, PA.



## This will tell you...



## WHAT'S IN THE AIR

● The device shown is a Dorex Air Pollution Test Unit. Chemical process companies, in particular, find it a most effective and economical means of getting an exact check on air contaminants. It works this way—

A small blower draws contaminated air uniformly through specially activated carbon, which absorbs all gaseous impurities from the air passed through it. At the end of a definite time, the carbon canisters are sent to the Dorex laboratory where the collected impurities are carefully analyzed. They then tell you what the impurities are, and their precise concentration.

With these data, you can easily set up a system of air purification for your plant—whether for indoor comfort and maintenance of quality control in manufacture, or for the abatement of a nuisance outdoors.

For full information, just mail the coupon. No obligation, of course.

W. B. CONNOR ENGINEERING CORPORATION

dorex air recovery

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**Dept. C-62, Danbury, Connecticut**

Please send me, without obligation, full information about the Dorex Air Pollution Test Unit.

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# ACEC manufactures ELECTRIC MOTORS for most industrial uses



VERTICAL HOLLOW SHAFT MOTORS — Squirrel Cage — 3-phase — Drip Proof — High Thrust — Standard Reverse Protection Clutch — Up to 75 hp. (larger sizes built to order)

Whether you're looking for a small motor, large one, or a really big-capacity job, you can do no better than specify "ACEC." For today's ACEC electric motors — products of Ateliers de Constructions Electriques de Charleroi, of Belgium — are backed by 70 years' designing and manufacturing experience, *plus* the facilities of 4 great, modern plants. Unexcelled in precision and dependability, they are *built to give every possible satisfaction in service.*

Conforming strictly to NEMA SPECIFICATIONS, outstanding 3-phase ACEC units are now *immediately available* from warehouse stocks in the United States; and a network of ACEC Distributors and Service Shops, across the nation, is prepared to handle customers' service needs promptly and efficiently.

Shown here are three widely used types of ACEC pump motors. We shall be glad to send you INFORMATIVE BULLETINS on these — and on all other motors we manufacture.

Whatever your requirements, write, wire, or telephone the nearest ACEC office or representative — or communicate directly with us in New York. Inquiries and orders receive immediate attention.



TYPE P VERTICAL SOLID SHAFT MOTORS — Squirrel Cage — 3-phase — Drip Proof — High Thrust. 900 to 3600 rpm — ¼ to 25 hp. (larger sizes built to order)



TYPE C FACE MOUNTED MOTORS — Squirrel Cage — 3-phase — Drip Proof — 900 to 3600 rpm — ¼ to 50 hp. (larger sizes built to order). Standard or Long Shaft Extension.

NOW ON HAND

**...Integral Horsepower Electric Motors NEMA — FULLY GUARANTEED**

Available in the following types:

- ★ *Open Drip Proof Motors*
- ★ *Totally Enclosed Fan Cooled Motors*
- ★ *Pump Motors (as illustrated)*
- ★ *Adjustable Speed Schrage Motors*

IMMEDIATE DELIVERY from New York, Chicago, Kansas City, New Orleans, Dallas and Los Angeles warehouses

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**What's your problem?**

Many of America's leading chemical industries have found the answers to problems in these processes in products by

**FILTROS**



The complete line of FILTROS porous, acid proof, silica and chemical porcelain products includes . . . .

Flat and Curved plates
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FILTROS is supplied in a wide range of permeability and is air tested to assure absolute uniformity. Much of FILTROS annual sales volume consists of highly specialized porous ceramic products made to individual specifications in cooperation with customers chemists and engineers. A number of chemical, electrolytic, and catalytic processing problems have been solved in this way by FILTROS where nothing else could accomplish satisfactory results.

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FILTROS engineers will gladly cooperate with you on any special problems. Write for detailed information and tell us how we may help.

FILTROS, INC.

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Pioneer Manufacturers of Porous Ceramics — Since 1913




# Koppers Resorcinol

★ SAVES TIME ★ REDUCES COST
★ PRODUCES BETTER PRODUCT

RESORCINOL is of particular interest in its characteristic of reacting like phenol — but with markedly greater reactivity. This greater activity has been utilized commercially with gratifying profit results.

For example, in heat reactive phenol-formaldehyde resins, the addition of resorcinol in the formulation can markedly reduce curing time or curing temperature or both.

In the adhesive field, a pure resorcinol-formaldehyde adhesive will cure at room temperature in 8-10 hours without catalysts that may injure cellulosic fibers. At an elevated temperature, such as 120°F., the same resorcinol adhesive will cure in about one hour. Straight phenolic adhesives, unless rendered strongly acidic, are not active at these temperatures and must be heated to 200°F. or higher. Either way—by lowering cure temperature, or reducing curing time—resorcinol produces a saving that more than offsets its higher cost.

In other combinations with phenol, or modifications of it, resorcinol may well be considered. Further, the reactive properties of the chemical are useful in other ways.

Small amounts of resorcinol-formaldehyde resin are being added to starch, which is used as an adhesive in solid fiber and corrugated box board. The resorcinol resin improves the water resistance of the starch adhesive bond.

Resorcinol is also being mixed with rubber latex to give a stronger bond between rubber and rayon tire cord.

Resorcinol has found a valuable application in the tanning of leather. After soaking in water, resorcinol-tanned leathers dry out in a flexible condition, instead of being hard and unpliable. Resorcinol-formaldehyde resins have further found application in the finishing of leather.

For your convenience in considering resorcinol, a bulletin is available. This contains technical information on properties, reactions and applications. Write for bulletin C-2-124.

KOPPERS

*For further information write to:*

**KOPPERS COMPANY, INC.**
**Chemical Division, Dept. CE-6**
**Koppers Building, Pittsburgh 19, Pa.**

# hot liquids

# corrosives

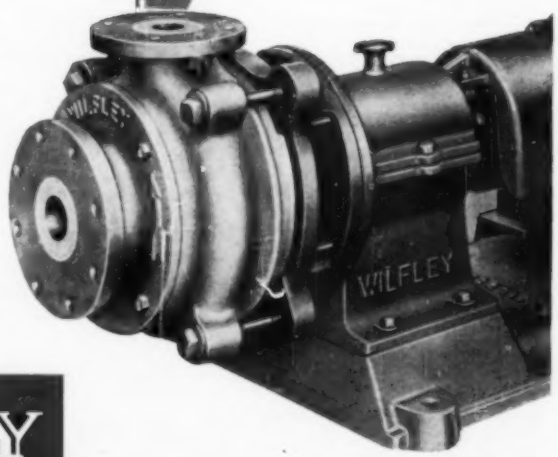
# acids

*Buy* **WILFLEY** *for cost saving performance*

*Companion to the famous* **WILFLEY** *Sand Pump*

• For more efficient performance... greater economy of operation... specify **WILFLEY "AF"** Acid Pumps. Dependable, trouble-free operation, on a round-the-clock schedule, with consequent stepped-up production and worthwhile power savings, are big reasons why modern chemical and processing plants all over the world now rely on **WILFLEY** Acid Pumps for handling acids, corrosives, hot liquids and mild abrasives.

• Available in 10- to 2,000-G.P.M. capacities, 15- to 150-ft. heads and higher. Wetted parts of practically all machineable alloys. Plastic lined models available. Every application individually engineered. Write or wire for details.




# WILFLEY *Acid* PUMPS

**A. R. WILFLEY & SONS**, Inc., Denver, Colorado, U.S.A.

New York Office: 1775 Broadway • New York City

SK Engineering News

# HACHMEISTER-INC. REVEA S BENEFITS OBTAINED BY SK STEAM JACKETED PUMP'S PERFORMANCE

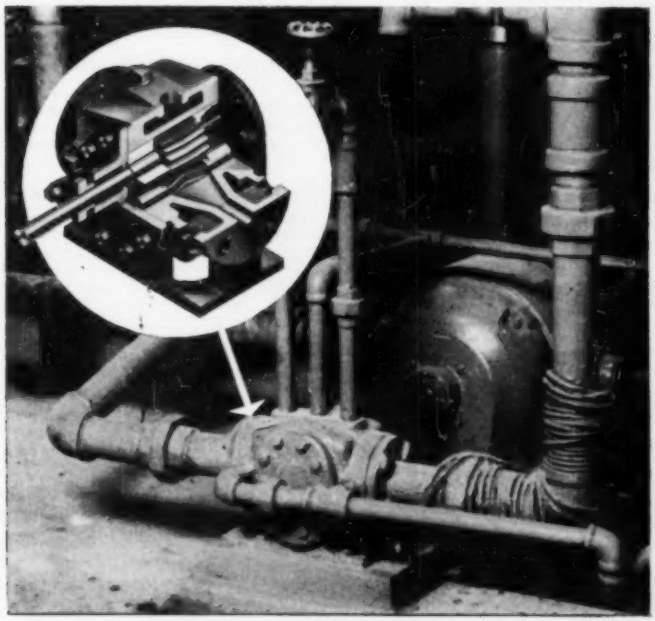
("On-The-Job" Illustration and Story by Courtesy of Hachmeister-Inc. of Pittsburgh, Pa., makers of Hako Products)

"SK Steam Jacketed Pumps have proved very advantageous for us," states Mr. H. J. Snyder, Plant Engineer, Hachmeister-Inc., and tells why as follows:

"We have benefited in our operations because: First, the steam jacket eliminates the need for outside heating necessitated by the viscosity of our material; second, they pump a wide range of thick and thin liquids equally as well; third, they have greatly increased our capacities; and fourth, absolutely no maintenance has been required since installation."

Three years ago, Hachmeister-Inc. installed the SK Steam Jacketed Gear Pump illustrated for use in connection with the manufacture of Hako-Short. Since then, the pump has been used to distribute various fats and oils from storage to mixing and blending kettles. It is gravity fed from three 300 gal. stainless steel kettles and pumps the material a vertical distance of 10 ft. and a horizontal distance of 42 ft. to supply three other 300 gal. mixing kettles. Using 2" ID inlet and discharge pipes, the pump handles approximately 15 gpm of material.

*If you are handling or are planning to handle liquids with viscosities which necessitate the use of high temperatures, investigate this pump. Details are available on request.*



## SIMPLE JET HEATER HEATS AND CIRCULATES LIQUIDS IN TANKS

SK Fig. 315 Circulating Heaters operate on jet principle to heat and circulate liquids in open tanks. Steam enters heater through inlet at top of heater and issues through a double steam nozzle in the form of two jets—one an annular suction jet and the other a straight forcing jet. The entrainment action of the suction jet draws tank liquid into mixing nozzle

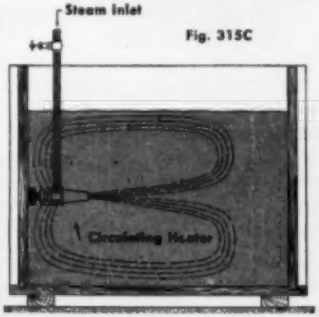


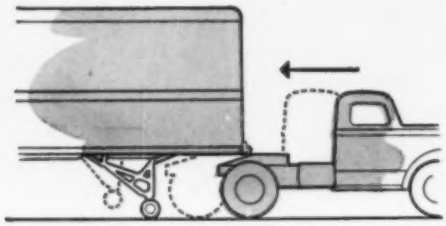
Fig. 315C

and discharge tube where it is heated by the steam. The forcing action of the central steam jet discharges liquid from heater and causes continuous circulation within tank.

These heaters offer several outstanding advantages which are explained in detail in Bulletin 3-A. Ask for a copy.

Manufacturing Engineers

# POWDER HAULING MADE *SAFER* BY FRUEHAUF ENGINEERING



**FRUEHAUF**
***Full Automatic* Supports**
**add Safety—Save Time, Effort, Cost.**




DURING World War II, Fruehauf and Army Ordnance engineers successfully developed the Full-Automatic, Cab-Controlled Van-Semi-Trailer for maximum safety and efficiency in moving explosive powder. Nearly 3,000 of these exclusive Fruehauf units were built. They received universal acceptance by both government and privately operated plants throughout the country.

An improved Fruehauf Powder Haul Van is now available. An outstanding example of Fruehauf engineering and manufacturing experience, it incorporates every possible special safety feature to eliminate human contact with the Trailer and minimize powder hauling hazards.

## Hazards Minimized by these Special Safety Factors

1. All *interior body surfaces are of non-sparking non-ferrous metals.*
2. Interior walls and doors are lined with laminated wood fastened with brass screws.
3. The sturdy oak floor is fastened by brass bolts to a steel sub floor.
4. Maximum-opening full-width rear doors and optional side doors swing back parallel to Trailer sides for most efficient loading and unloading.
5. All outside panels are completely weather-lapped, and watersheds above doors prevent leakage.
6. All wiring is protected by conduit and weatherproof junction boxes and connections.

### *FULLY* AUTOMATIC COUPLING

Coupling is completely cab-controlled. The driver simply backs the tractor under the Trailer, which locks the king pin and raises the automatic supports in one motion. There is no cranking.

### *FULLY* AUTOMATIC UNCOUPLING

Uncoupling is quick, safe, and completely cab-controlled. The driver merely operates a hand lever inside the cab to disengage the king pin, then drives away. Supports are automatically lowered and locked in the down position.

### *FULLY* AUTOMATIC CONNECTIONS

Lights and mechanical brakes are automatically connected through the hollow king pin during coupling, and automatically disconnected during uncoupling. Brakes are set automatically to prevent rolling when Trailer is uncoupled.

**HUMAN CONTACT IS ELIMINATED!**

**THE DRIVER NEVER LEAVES THE CAB!**

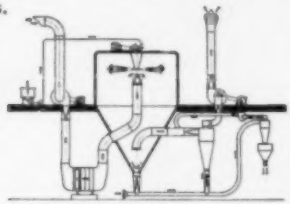
**FRUEHAUF TRAILER COMPANY • DETROIT 32, MICHIGAN**

**FRUEHAUF *Trailers*** "ENGINEERED TRANSPORTATION"

*Have a Drying Problem?*

**...use Nerco-Niro Spray Dryers**

The experience gained through more than 250 Spray Dryer installations throughout the world is at your service. Let us solve your chemical drying problems.



At right: Typical Nerco-Niro Spray Dryer Flow Diagram.

Nerco-Niro Spray Dryers offer to the chemical industries the following features:

1. Maximum solids recovery.
2. Product quality and uniformity.
3. Gentleness of drying.
4. Low maintenance and labor cost. Ease of cleaning.
5. Low consumption of power and heat.

Every industrial Spray Dryer installation is individually engineered.



At right: Portable 34" Nerco-Niro Spray Dryer.

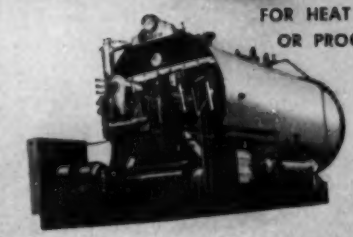
NERCO NIRO

*Laboratory facilities available for test purposes.*

NICHOLS ENGINEERING & RESEARCH CORP.
NERCO-NIRO SPRAY DRYER DIVISION
70 Pine Street, New York 5, N. Y.
INDIANAPOLIS PASADENA MONTREAL

**STEAM**

FOR HEAT OR PROCESS



A complete steam plant backed by undivided responsibility • Shipped completely assembled • More than 80% thermal efficiency guaranteed • 4-pass design provides 5 sq. ft. of heating surface per b.h.p. • Built-in induced draft eliminates need of expensive chimney • Simple installation • Clean, quiet operation • Heavy-duty construction assures long-lived dependability

Superior Steam Generators are manufactured in 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i. or for hot water heating.

For complete details, write for Catalog 322

Factory: Emmaus, Pa.

Exec. Offices: Times Bldg., Times Sq., New York N. Y.

Superior STEAM GENERATOR

**GAYCO CENTRIFUGAL SEPARATORS**

GAYCO Separators, equipped with the adjustable centrifugal sizing fan—an exclusive GAYCO feature—make closer separations. Closer separations bring about higher production through efficient removal of the fines made by the mill. Closer separations bring about higher quality products by eliminating all undesirable oversize.

**"TIMKEN GEARING EQUIPPED" GAYCO brings you all these:**



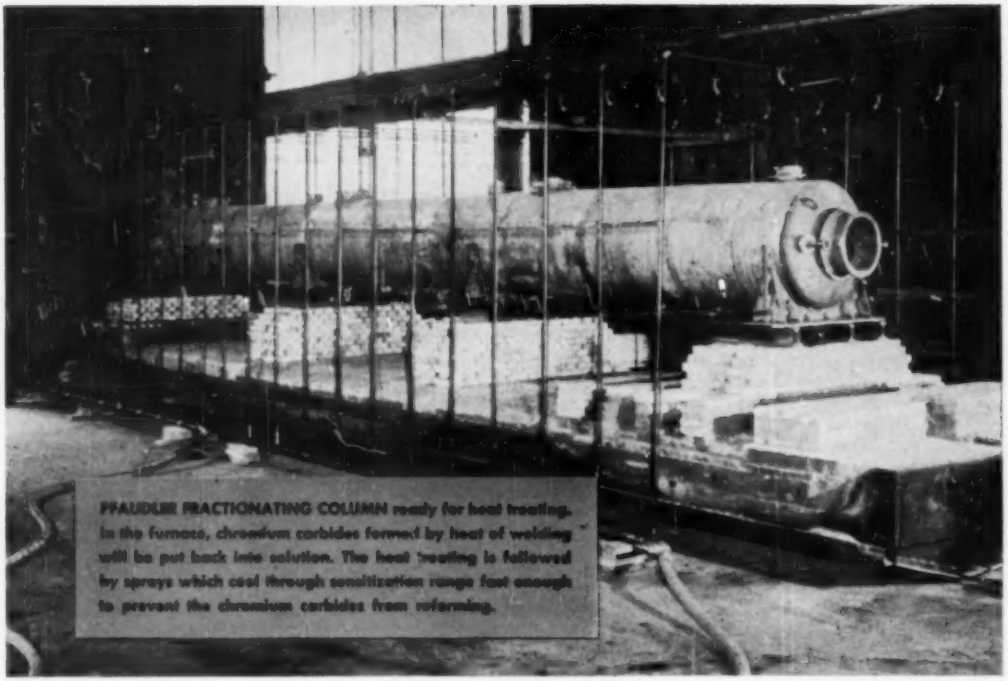
Range 60 to 400 mesh
Greater capacity 25 to 30% greater production
Cleaner Tailings
Uniform Products
Slow speed for slow wear
Quick and easy adjustments

If you have an exceptionally hard separating problem TRY THE GAYCO

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Canadian Representative: F. H. Hopkins & Co., Ltd.
8500 Decaire Blvd. Montreal, Que.



PFAUDLER FRACTIONATING COLUMN ready for heat treating. In the furnace, chromium carbides formed by heat of welding will be put back into solution. The heat treating is followed by sprays which cool through sensitization range fast enough to prevent the chromium carbides from reforming.

# Putting the heat on alloy corrosion problems

## Pfaudler's extensive heat-treating facilities permit application of non-critical alloys to chemical processing equipment for highly corrosive services

Unstabilized stainless steels—when *properly heat treated*—can replace the more critical stabilized stainless steels for many chemical processing uses.

Columbium and titanium have been commonly used as stabilizing agents to overcome the decrease in chemical resistivity found in the heat affected areas of welded, unstabilized stainless steels. This decrease is caused by carbide precipitation during welding.

Proper heat treatment of the unstabilized 300 series stainless steels, however, can restore the chemical resistivity of fabricated equipment for chemical service . . to a degree equivalent or superior to that obtained with the stabilized materials which are now critically short. And the heat-treating method is generally more economical.

PFAUDLER—with more than 25 years experience in fabricating corrosion resistant equipment from virtually all metals and their alloys, and with unique furnace facilities for fusing glass to steel—is ideally equipped for heat treating stainless steel. Pfaudler furnaces are large enough to handle equipment up to 12′ 6″ in diameter and 45′ 6″ in length.

What is *your* corrosion problem? As corrosion engineers, Pfaudler is prepared to make an *impartial* analysis of your requirements . . . and recommendations to meet your needs economically.

For the full story on heat treating stainless steel processing equipment, write us for a copy of "Preventing Intergranular Corrosion Due to Welding Stainless"—reprinted from the March, 1952 issue of *Chemical Engineering*.

**Pfaudler**

**THE PFAUDLER CO.**
**ROCHESTER 3, N. Y.**
***Engineers and fabricators of corrosion resistant process equipment***

GLASS-LINED STEEL • HASTELLOY • ALUMINUM • TANTALUM • CARBON STEEL • SOLID OR CLAD STAINLESS STEEL • NICKEL • INCONEL • MONEL

# traps help uncover hidden steam treasure




**The facts are these:**

A large southern chemical company about a year ago was up to capacity on their boilers. New process units were being added, requiring more steam—a new boiler seemed inevitable.

About that time they began replacing their old-type traps and bleed-off valves with Yarway Impulse Steam Traps and Strainers. Today, even with the new process units added, their daily steam consumption is nearly 100,000 lbs less than a year ago—the superintendent gives Yarway Impulse Traps credit for the saving.

Yarway Impulse Traps are *designed* to insure sending the most premium B.T.U.'s at top temperature into your product or process . . . *to get equipment hotter sooner and keep it hot!*

Yarway's have 11 other advantages, too—such as *small size, low maintenance, low cost, and availability* from over 200 Industrial Distributors. Write for Bulletin T-1740. Or for steam trap advice, call on your nearby Yarway service engineer.




**YARNALL-WARING COMPANY**
137 Mermaid Avenue, Philadelphia 18, Pa.

**the steam trap designed with more production in mind**

# EVIDENCE OF SUPERIORITY IN *Corrosive Service*



**BEFORE** *Midwest 4" extra heavy weight, carbon steel tee showing original wall thickness of tee at right before it was accidentally subjected to corrosive conditions.*



**AFTER** *When straight pipe in line had failed from corrosion, this Midwest tee was removed. Note amount and uniformity of wall thickness remaining.*

A valve leaked or somebody opened it by mistake . . . so the Midwest Tee shown above was subjected to dilute hydrofluoric acid in addition to its normal service in a 300° F. hydrocarbon line on an alkylation unit.

The highly corrosive acid caused failure of the straight pipe . . . so the entire line had to be replaced. When cut out of the line, the Midwest Tee was found to have a considerable (and uniform) wall thickness. There was no selective corrosion and the weld held up even better than the parent metal.

This was not special alloy made to resist corrosion, but regular Grade "A" carbon steel . . . the same as the new tee shown left above. We do not, of course, recommend carbon steel for corrosive conditions, but, in emergency, it gives good account of itself.

The exclusive Midwest manufacturing process produces fittings of superior metallurgical properties. The metal is worked in compression . . . it is not stretched or extruded, and distribution is uniform. After forming and welding, the fitting is stress-relieved. For further information, write us for a copy of Catalog 48.

**MIDWEST PIPING & SUPPLY CO., INC.**

Main Office: 1450 South Second Street, St. Louis 4, Mo.

Plants: St. Louis, Passaic, Los Angeles and Boston

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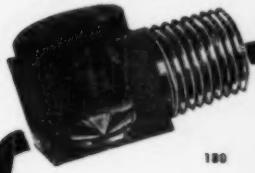
## MIDWEST WELDING FITTINGS

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**Advanced design features a single round tangential inlet (instead of several small slots). Relatively large solid particles can pass right through and out the orifice. Produces a hollow cone spray with fine break-up and even distribution—ideal for many types of applications.**



180

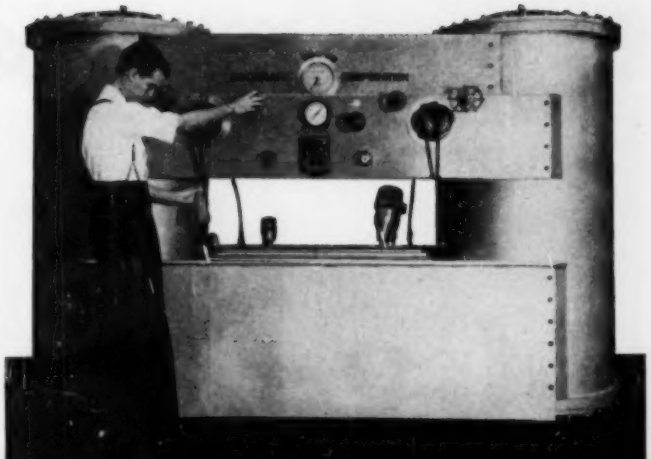
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**In many industries Monarch Spray Nozzles are used for:**

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*Let us send you Catalogs 6A and 6C*

**MONARCH MFG. WKS., INC.**
**2517 E. ONTARIO ST.**
**PHILADELPHIA 34, PA.**



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From small laboratory mills to high tonnage mills, American Crushers — with *built-to-the-job efficiency* — are famous for long-time service at *lowest possible* cost.

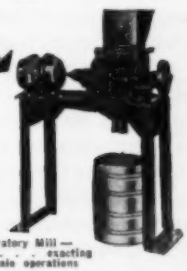


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# DRUM RINSER

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We would appreciate additional information on processing _____ (Product) (Quantity)

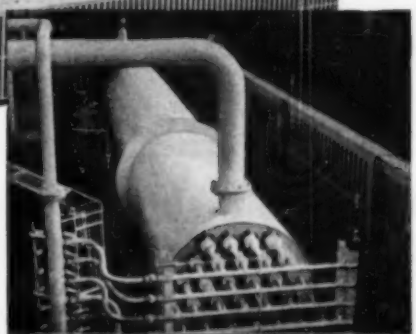
# fluor's modern research facilities

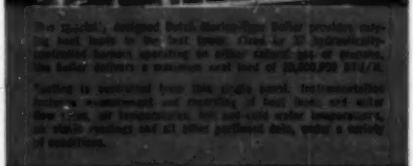
## test new developments — verify efficiency

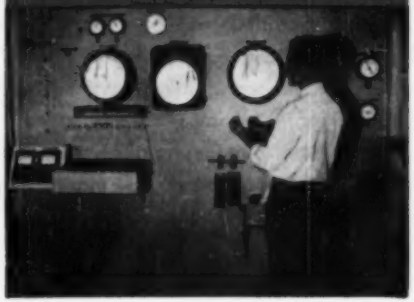
At Fluor, the proof of the design is in the testing. *Before* new Cooling Tower developments are incorporated into standard design, they are subjected to rigorous tests in this modern, commercial-size tower testing laboratory. Here, design and performance efficiency of every new development is determined through complete ranges of actual heat transfer conditions. Realistic rating data is established under conditions *paralleling* those of plant and process operations.



Fluor Cooling Tower Testing Facilities. This commercial-size installation consists of a pump house, instrument house, 20,000,000 BTU/H boiler, test basin, and a 40' high test tower.







### *What this means to you . . .*

The motivating power behind Fluor's continuous research and development program is to *always* provide the most efficient cooling tower available. This fact, combined with Fluor's 30 years of active experience in designing major cooling tower installations for the petroleum, chemical, and power industries, means many things to the man seeking a factual tower recommendation to meet his exact cooling requirements.

A Fluor Cooling Tower recommendation means that all variables are included and compensated for. It means that all component parts, as well as all design theory, have been tested and evaluated under actual operating conditions. And, it means that a Fluor-designed cooling tower will perform at *rated* heat transfer efficiency under the conditions of installed operation. *You can be sure with Fluor!*

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**PIPE and FITTINGS**

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# Lapp TUFCLAD



# Lapp

**PROCESS EQUIPMENT**

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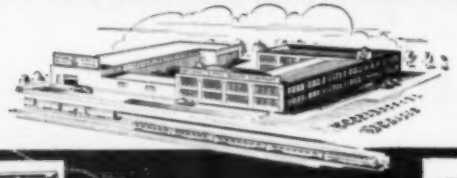
For problems involving severe corrosion or freedom from metallic contamination, the chemical processing industry has found no more effective—or economical—material than Lapp Chemical Porcelain. Now this same solid porcelain material is available with TUFCLAD, a new *tough* armor which greatly adds to operating security—protection of personnel and equipment—certainty of avoiding product loss.

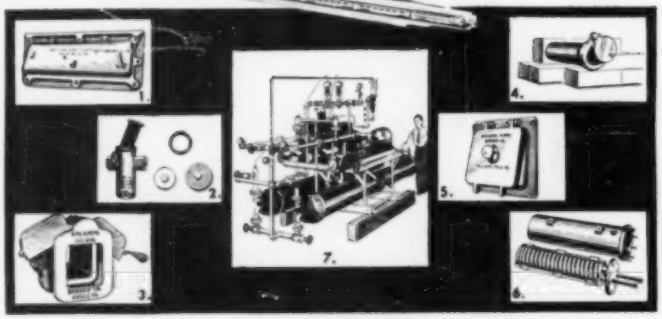
TUFCLAD is woven Fiberglass fabric, impregnated and bonded in multiple layers to the porcelain body with an Epoxide resin of high strength and chemical and heat resistance. Armor is tightly knit to porcelain and runs end-to-end, *under* flanges.

In operation, TUFCLAD provides a cushion to protect porcelain against accidental damage in handling or operation—and an insulator against thermal shock. But most important, the TUFCLAD shell is of itself homogeneous and *tough*—fully able to hold operating pressures against gross leakage even though porcelain is damaged by accident, explosion or fire.

Write for description and specifications of Lapp TUFCLAD-armored Porcelain valves, plug cocks, safety valves, flush valves, pipe, fittings and special shapes. Lapp Insulator Co., Inc., Process Equipment Division, 504 Maple Street, Le Roy, N. Y.

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# COMBUSTION ACCESSORIES






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1. Air Control Door and Frame, top hinged, ratchet type, heavy duty, for manual control. Surfaces are machined to a close fit.
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7. Fuel Oil Pumping and Heating Unit . . . Twin or Single Pumps, Steam driven, Electric driven or combination Steam-Electric, with Single or Double Fuel Oil Heaters and accessories for feeding oil at constant pressure and temperature.

. . . yes, just as we are proud of supplying the *right* liquid fuel or gas burning equipment (over 40 years experience throughout industry), so, also, are we proud of our full line of highest quality accessories to supplement your every combustion need. Within our modern, "daylight" factory, salesrooms and general offices NATIONAL AIROIL likes and adheres to the phrase, "nothing but the best"! We believe that our record speaks for itself . . . i.e.; the "right combination" for you in achieving maximum combustion economy is: NATIONAL AIROIL Fuel Oil, Gas or Combination Oil and Gas Burning Equipment; NATIONAL AIROIL Combustion Accessories; and, NATIONAL AIROIL Engineering Consultation.

May we be of help to you in accomplishing your particular installation or in solving that difficult problem?

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INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT



# ACCURATE PROCESS CONTROL *with* W&T MERCHEN FEEDERS



W&T Merchen Scale Feeder

Successful process control — particularly in today's modern, high-speed plants — generally depends on the accurate feeding of dry, free-flowing, chemicals. Continuous, precision feeding — *by weight* — is essential to a uniform end product. And that's what W&T Merchen Scale Feeders can demonstrate in *your* plant, just as they are doing in hundreds of others.

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These feeders will handle from a few ounces to several thousand pounds per minute — and, of particular importance in many plants, they can be completely synchronized with other equipment, or equipped for remote or automatic control. For example, Merchen Feeders are equipped to stop automatically and at the same time stop all other synchronized process equipment if the delivery of material for any reason should vary from the rate of feed pre-set on the scale beam.

**SERVICE** — A nationwide service organization is prepared to suggest the proper W&T Merchen Feeders for your process and to give prompt service and installation supervision on Merchen Equipment.

Write today for additional information on W&T Merchen Scale Feeders.

**WALLACE & TIERNAN COMPANY, INC.**

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# *Yours for the asking—*




## A VOLUME OF DATA

*. . . covering welding fittings and forged steel flanges . . .*

## ON A SINGLE SHEET

Here is just about the handiest tool ever devised for the pipe designer. Data on welding fittings and flanges that otherwise could be found only by plowing through many catalog pages and tables have been ingeniously condensed on the two sides of the durable letter-size card illustrated above.

One side covers the broad WeldELL line of Taylor Forge welding fittings. For every nominal pipe size, ½" through 30", it shows the wall thickness for every weight of every fitting in every available material. It also shows all required dimensions of all types of fittings.

The other side covers the world's most complete line of forged steel flanges. For every nominal pipe size, ½" through 24", it gives all essential dimensional and bolting data for all types of flanges in all weights. A particularly useful table (see reproduction) is that showing welding neck flange bores which enables you to determine the I.D. of any nominal pipe size without separate calculation. Thus the sheet gives you O.D. and I.D. of any weight of pipe.

The card is varnished to make it stand the steady usage you are certain to give it. To obtain your copy see your Taylor Forge distributor or **MAIL THE COUPON.**

Please send me one of your fitting and flange sheets!

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COMPANY_____

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TF

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Offices in all principal cities.

Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada

# BACK IN THE 1880's

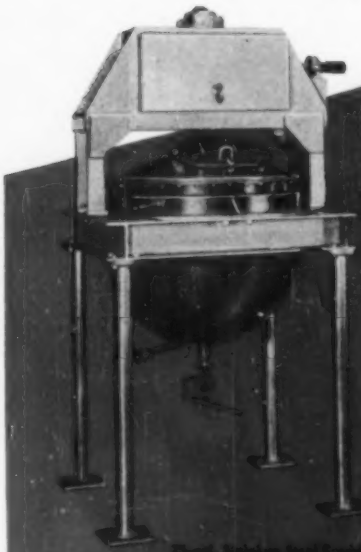
WHEN THE FIRST REVOLVING DOOR WAS DESIGNED



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WAS MAKING INDIVIDUALIZED

## CHEMICAL EQUIPMENT



In an era that bred ingenuity, the revolving door appeared to add an efficient touch scene. But even before then, KOVEN had opened another door, one that led to speedier through Individualized Equipment. Now — in when production peaks must be achieved — manufacturers rely even more on der in steel fabrication. This is because they pment — tailored to fit their exact needs — production deadlines and nets greater profit through greater efficiency.

onsultation — no obligation. Complete X-ray inspection and stress relieving ity control. KOVEN equipment in all nd alloys include: pressure vessels, ondensers, kettles, tanks, chutes, ers, stacks, coils. Fabrication to ar. U-68 and U-69 a specialty.



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**Hooker Chemical Guide**
(ONE OF A SERIES)

**USE** this handy reference to save time in selecting high quality chemicals.

# HOOKER ACID CHLORIDES

## SULFURYL CHLORIDE



Synonym: Sulfuric Oxychloride
Formula: $SO_2Cl_2$
Appearance: Light yellow liquid

**TYPICAL PROPERTIES**

| | |
|---|---|
| Molecular Weight | 135.0 |
| Pour Point | below −54°C |
| Distillation Range | 2° incl. 69.5°C |
| Specific Gravity, 15.5°/15.5°C | 1.680 |
| $SO_2Cl_2$ Content | 99% Min. |

**USES**

**Chlorinating Agent:** In the production of chlorophenol, chlorothymol, pharmaceuticals, dyestuffs; reacts with organic acids to form chlorides and anhydrides.

## THIONYL CHLORIDE



Synonym: Sulfurous Oxychloride
Formula: $SOCl_2$
Appearance: Clear, pale yellow to red liquid

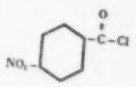
**TYPICAL PROPERTIES**

| | |
|---|---|
| Molecular Weight | 119.0 |
| Pour Point | −75°C |
| Distillation Range | 75° to 78°C |
| Specific Gravity, 15.5°/15.5° C | 1.640 |
| $SOCl_2$ Content | 97.5% Min. |

**USES**

**Chlorinating Agent:** To replace various groups with chlorine. Among end products are: isoamyl chloride, synthetic pyrethrum, phenyl propyl chloride and synthetic Vitamin A palamitate, antihistamines.

## PARANITROBENZOYL CHLORIDE



Formula: $NO_2C_6H_4CO\,Cl$
Appearance: Yellow crystalline lumps or flakes

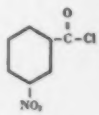
**TYPICAL PROPERTIES**

| | |
|---|---|
| Molecular Weight | |
| p-Nitrobenzoyl Chloride | 185.5 |
| Melting Point | 97% |
| Distillation Range at 103 mm | 70.5°C |
| | 202° to 205°C |

**USES**

**End Products:** Procaine, dyestuffs

## METANITROBENZOYL CHLORIDE



Formula: $C_6H_4NO_2CO\,Cl$
Appearance: Yellow to brown liquid, partially crystallized

**TYPICAL PROPERTIES**

| | |
|---|---|
| Molecular Weight | 185.5 |
| Last Crystal Point | 28° to 31°C |
| Distillation Range | 275° to 278°C |

**USES**

**End Products:** Dyestuffs for fabrics and color photography; pharmaceuticals.

## BENZOYL CHLORIDE



Formula: $C_6H_5CO\,Cl$
Appearance: Clear, colorless to light yellow liquid

**TYPICAL PROPERTIES**

| | |
|---|---|
| Molecular Weight | 140.5 |
| Freezing Point | −0.9°C |
| Boiling Point | 197.3 |
| Specific Gravity, 15.5°/15.5°C | 1.219 |
| Benzoyl Chloride | 99% |

**USES**

**End Products:** Intermediates, dyes, perfume bases, pharmaceuticals, polymerization catalysts, flour bleaching agents, plasticizers, resins, etc.

**Specific Compounds:** Benzyl benzoate, benzoyl peroxide, benzophenone and others.

**For detailed information on items listed,** drop us a note on your letterhead. Address your request to HOOKER ELECTROCHEMICAL COMPANY, 5 Forty-Seventh St., Niagara Falls, New York.

**HOOKER ELECTROCHEMICAL COMPANY**

NIAGARA FALLS, N. Y. • TACOMA, WASH. • WILMINGTON, CALIF.

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HOOKER CHEMICALS

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**in many applications . . .**




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Red Diamond Carbon Dioxide is filling many of the increasingly diverse needs of industry and doing the job better at less cost. As a refrigerant, a pressure medium, an inert gas—in chemical processing and many other applications its use is constantly expanding.

Complete technical service is available to industrial users everywhere. Mail the Coupon today.

$CO_2$ in all its forms by Liquid

GAS • LIQUID • SOLID (DRY ICE)

*World's Largest Producers of $CO_2$*
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Please have one of your engineers see us to discuss applications of Red Diamond $CO_2$.

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*You Get Even, No Glare*
**LOW COST LIGHTING**
*for Gages, Rotameters, etc.*
*with*
**JERGUSON**
**Explosion-Proof**
**GAGE ILLUMINATORS**



*Single and Double Section Jerguson Illuminators on a 3-Section Gage.*

**UNDERWRITERS' LABORATORIES APPROVED**

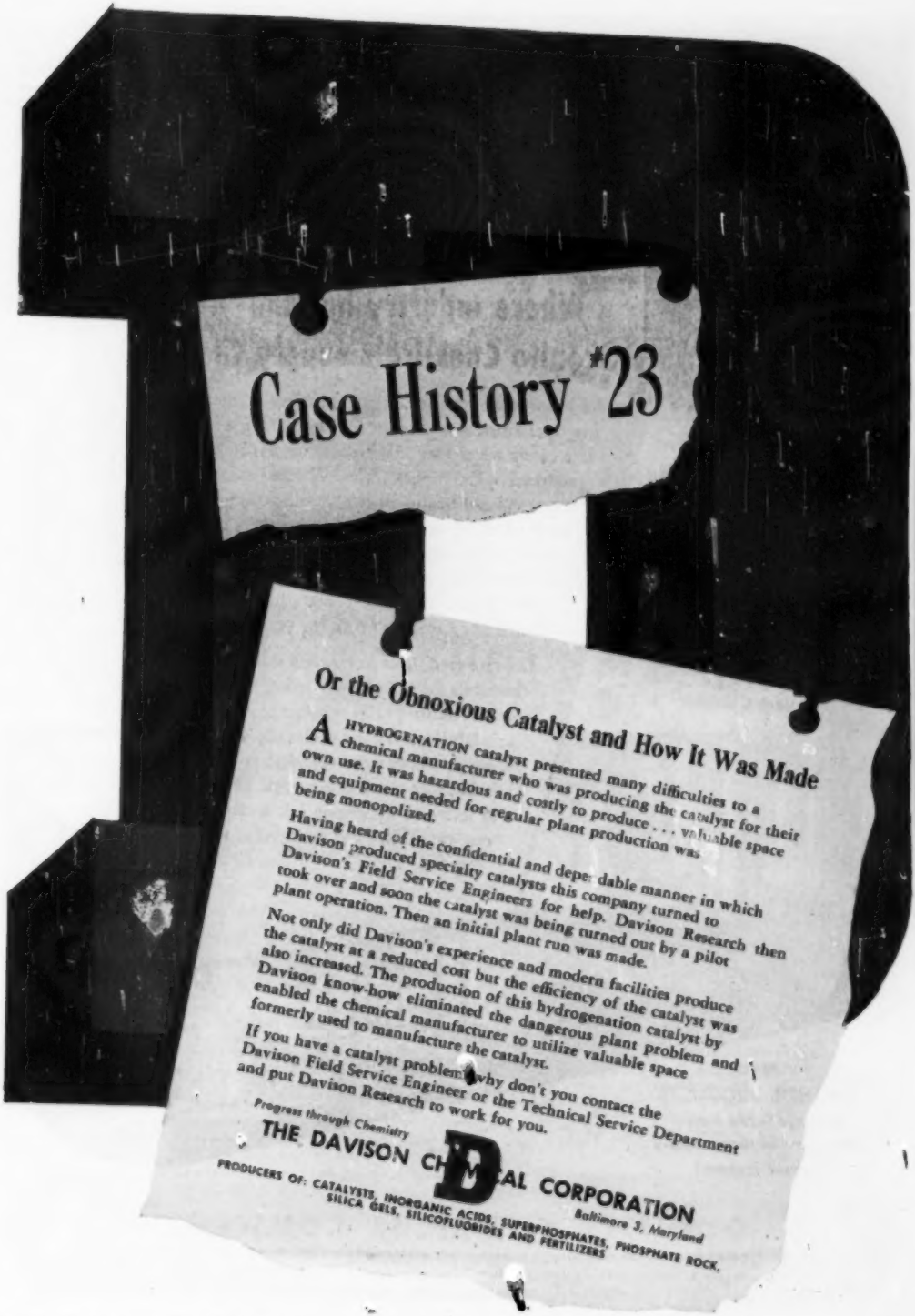
YOU get even, no glare, Low Cost Lighting with Jerguson Gage Illuminators . . . the improved illuminators that are unexcelled for gages, rotameters, etc. They give you ideal illumination with safety . . . and make possible faster, easier, accurate reading.

Jerguson Illuminators use the principle of solid wedge lighting to give you *clear, even lighting, without bright spots.* Light flows through the plastic wedge and is reflected evenly. A single small bulb gives you better illumination at a cost so low that savings quickly pay for the illuminator.

Jerguson Illuminators are approved by Underwriters' Laboratories and are built in accordance with their Standard for Electric Lighting Fixtures for use in hazardous locations for Class 1, Group D Services. Made in a variety of sizes; also available in a non-explosion proof model.

*Investigate Today. Write for Data Unit on Jerguson Illuminators*

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*Gages and Valves for the Observation of Liquids and Levels*
**JERGUSON GAGE & VALVE COMPANY**
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*Jerguson Trent Gage & Valve Co. Ltd., London, Eng.*


Case History #23
Or the Obnoxious Catalyst and How It Was Made
A HYDROGENATION catalyst presented many difficulties to a chemical manufacturer who was producing the catalyst for their own use. It was hazardous and costly to produce . . . valuable space and equipment needed for regular plant production was being monopolized.
Having heard of the confidential and dependable manner in which Davison produced specialty catalysts this company turned to Davison's Field Service Engineers for help. Davison Research then took over and soon the catalyst was being turned out by a pilot plant operation. Then an initial plant run was made.
Not only did Davison's experience and modern facilities produce the catalyst at a reduced cost but the efficiency of the catalyst was also increased. The production of this hydrogenation catalyst by Davison know-how eliminated the dangerous plant problem and enabled the chemical manufacturer to utilize valuable space formerly used to manufacture the catalyst.
If you have a catalyst problem why don't you contact the Davison Field Service Engineer or the Technical Service Department and put Davison Research to work for you.
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THE DAVISON CHEMICAL CORPORATION
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PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS, SILICOFLUORIDES AND FERTILIZERS

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THE NAME TO WATCH IN CHEMICALS

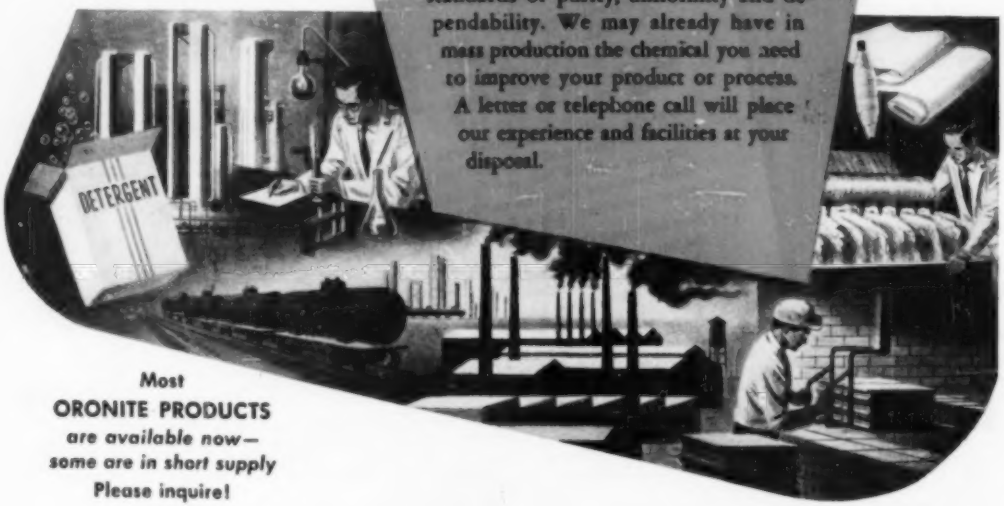
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An ever-increasing number of industries find their processing operations and product formulations are better and less costly when they use surface-active materials mass-produced by Oronite. Widely diversified uses include—improving the quality of cement blocks, adding efficiency to smog control systems, textile processing, emulsion prevention. (Scores of up-to-the-minute industrial uses and applications are described in a new booklet, "Detergents", just published. Write any Oronite office for your free copy.)

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***are available now—***
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2341

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PAYLOADER in the box car unloads bulk materials fast, easily, and at low cost.





TOUGH

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**looks mighty simple**



Screen Making—is simply a matter of making the right kind of openings of the right shape in the right arrangement in the right metal to fit into the well in the right manner so that the right amount of water can enter the pump bowl area with a minimum amount of resistance while holding back the sand formation. Outside of those details, the job is quite simple.

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If Layne builds your water supply units and if sand screen is necessary, your job will have the famous Layne horizontally slotted screen. This means that your well will have a longer life, produce more water and operate on a lower cost than is possible with ordinary conventional screens.

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**VERTICAL TURBINE PUMPS**

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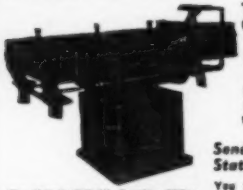
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For extremely fine grinding and uniformity of product, the principle of centrifugal impact with product carried by the air stream, has never been surpassed. Schutz-O'Neill Pulverizers utilize this principle to the fullest degree.



***Send us stock sample***
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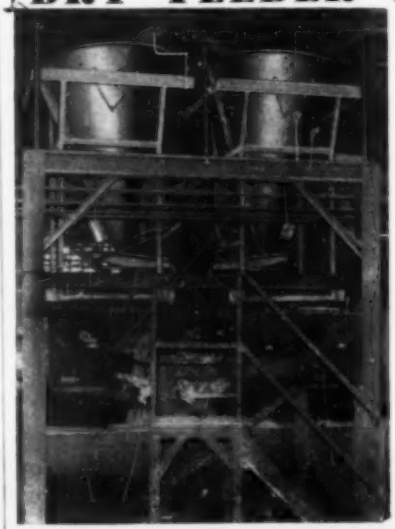
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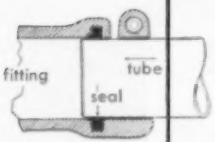


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for joining pipe or tube
**without threading or welding**

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Designed to reduce assembly costs and to permit the use of less expensive lighter wall tubing. ***Quikup!*** stainless steel elbows, tees, couplings, reducers and adapters save you time, labor, materials and money.




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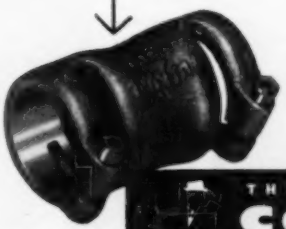
***Quikup!*** means economical maintenance! Downtime is cut to a minimum. Assembly and disassembly become a matter of minutes.

***Quikup!*** means safe, leakproof connections! Synthetic sealing rings provide positive pressure-tight joints at all times.

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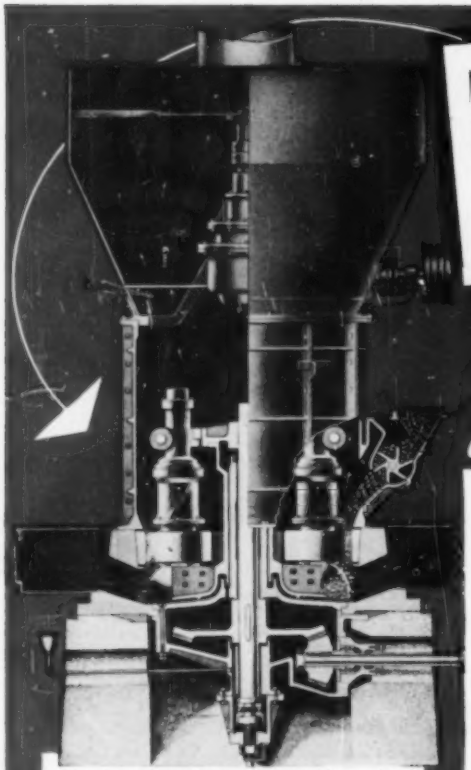
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Cross section of Roller Mill showing how material is ground by rolls rotating against bull ring, then air swept to separator which extracts fines and returns coarse material to mill for regrinding.

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...with greater uniformity

...at lower cost

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Heavy duty construction in many sizes for crushing and grinding to small size, in one operation, phosphate, gypsum, limestone, shale, bauxite, asbestos rock and virtually all other chemical and fibrous materials.

**HELIX-SEAL HAMMER MILLS**

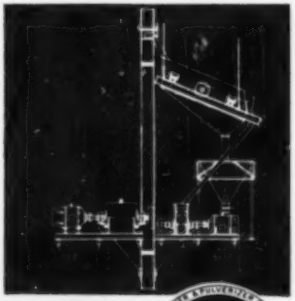
Dust-free fine grinding, 100 to 325 mesh, without fans, cyclones or air separators. Variable speed feed control. Will also handle wet, sticky, oily and greasy materials without clogging. Easy to install; inexpensive to operate.

**IMPACT and DRIER MILLS**
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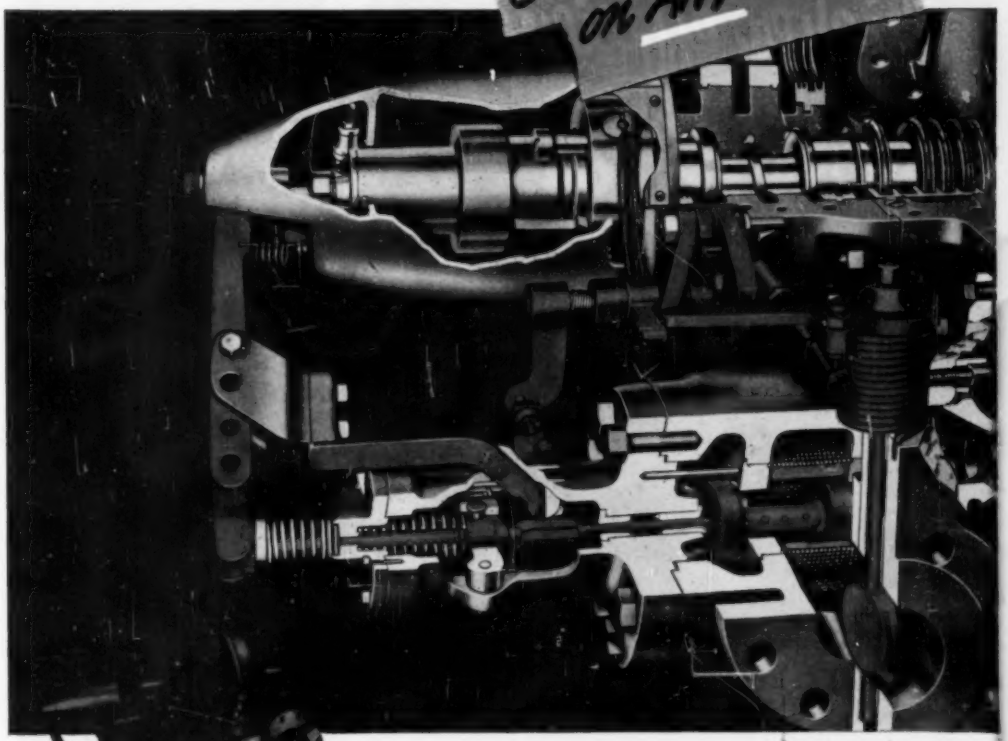
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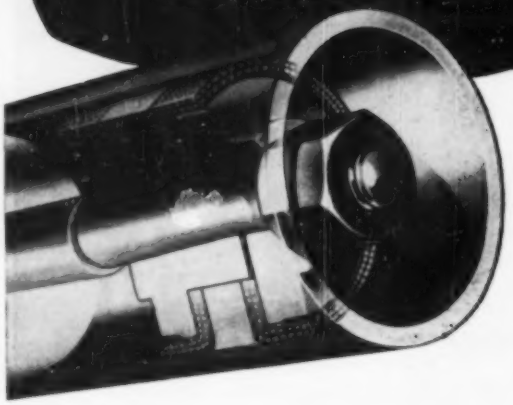
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**CONTROLLED VOLUME PUMPING**

OF "HARD-TO-HANDLE" CHEMICALS

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*Auto-Pneumatic*

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**NEW BULLETIN AVAILABLE.** Write for Bulletin 300, just issued. 24 pages of description, specifications, typical applications, flow charts. Lapp Insulator Co., Inc., Process Equipment Division, 333 Maple Street, Le Roy, N. Y.

# PUTTING IT ON THE LINE...

# *in Industry after Industry!*

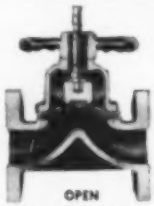
## The Grinnell-Saunders Diaphragm Valve . . . . . .

***Here's why*** . . . Piping in today's complex industrial plants is an exacting science involving the handling of highly corrosive fluids, gases, compressed air, beverages, foods and suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are costly factors. Under such conditions, the amazing adaptability of the Grinnell-Saunders Diaphragm Valve explains its acceptance by industry after industry.

Bodies of this versatile valve are made in a variety of metals — iron, stainless steel, bronze, aluminum and others. ***But of more importance*** is the fact that a body of cast iron (a metal not in short supply) can be lined with glass, lead, natural rubber, neoprene and other materials which, in many instances, handle corrosive fluids *better* than metals.

Diaphragms come in natural rubber, neoprene, butyl, hycar, a special synthetic for foods, and KEL-F. This last is chemically inert to all acids and alkalies in all concentrations with the exception of molten alkali metals.

From this broad selection of materials, the problems which the Grinnell-Saunders valve can solve are extremely varied. No wonder industry after industry is putting it on the line.



**OPEN**

Showing rising spindle . . . valves are available with rising or stationary spindle.

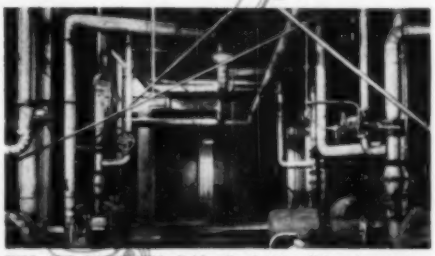


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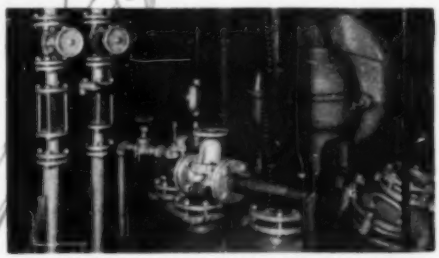
KEL-F diaphragm, using special rubber backing cushion and floating tube nut design.

**CHECK THESE GRINNELL-SAUNDERS FEATURES...**

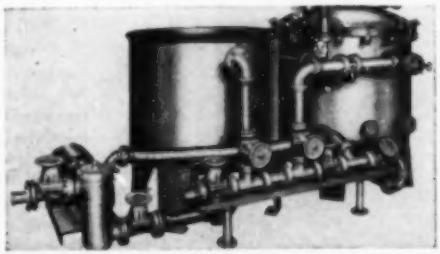
- Diaphragm absolutely isolates working parts from the fluid.
- Diaphragm lifts high for streamline flow in either direction.
- Diaphragm presses tight for positive closure.
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- Simple maintenance — diaphragm easily replaced.



**PULP AND PAPER MILL.** Rubber-lined Grinnell-Saunders Valves on stainless steel piping handle sulphate pulp stock in bleach plant of Potlatch Forests, Inc., Lewiston, Idaho.



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*Research Chemists and Engineers*
A staff of 75 including chemists, engineers, bacteriologists and medical personnel with 10 stories of laboratories and a pilot plant are available for the solution of your chemical and engineering problems.
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**EXCLUSIVE REPRESENTATION WANTED**

**LA. SOUTH MISS., MOBILE AREA** by well established firm of Mfgrs. Agents with two young, aggressive Registered Prof. Engrs. presently handling several excellent lines. Must be leading Mfgr. Prefer heavy equipment field applicable to Pet. Refineries, Chemical plants, Paper and board mills.

RW-3647, Chemical Engineering
330 W. 42nd St., New York 36, N. Y.

## CHEMICAL ENGINEER

Large Western New York synthetic organic chemical plant has attractive permanent position for Chemical Engineer, preferably with 2 to 3 years' industrial experience, for plant engineering project work. Reply to

P-4484, Chemical Engineering
330 W. 42 St., New York 36, N. Y.

## INDUSTRIAL ENGINEER

Large midwestern Cosmetic and Packaging Plant seeks Industrial Engineer capable of layout, planning, material handling. Good opportunity to become associated with one of largest and most aggressive companies in the country. Good pay. Permanent.

P-4344, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

*REPLIES (Box No.): Address to office nearest you*
*NEW YORK: 330 W. 42nd St. (36)*
*CHICAGO: 520 N. Michigan Ave. (11)*
*SAN FRANCISCO: 68 Post St. (4)*

## POSITIONS VACANT

**(Additional Positions Vacant Advertising on page 459)**

ASSISTANT MILL Metallurgist for large Copper Company Chile, South America. College graduate with some experience, to work in Mill Metallurgical Laboratory. 3-year contract. Transportation both ways and salary while traveling paid by company. In reply give complete details. P-4375, Chemical Engineering.

FIRST CLASS Mill Metallurgist to work directly under Assistant Superintendent and be in full charge all testing and research large copper concentrator Chile, South America. Graduate engineer required with experience in operation milling plants using crushing, grinding and froth flotation, etc. 3-year contract. Transportation both ways and salary while traveling paid by Company. In reply give complete details. P-4378, Chemical Engineering.

MECHANICAL ENGINEER to assist in supervision maintenance of fleet of Whitcomb Diesel Electric Locomotives, as well as general railway repair shops, large copper company Chile, South America. 3-year contract. Transportation both ways and salary while traveling paid by company. In reply give complete details. P-4381, Chemical Engineering.

PERMANENT POSITION open for young graduate mechanical or chemical engineer for the Engineering Division of a well known organic chemical company in Ohio. Desired, experience in repair, maintenance and construction. Give full information, with photograph, stating technical education, experience, personal status, references, and salary requirements. P-4545, Chemical Engineering, 330 W. 42nd Street, New York 36, N. Y.

YOUNG CIVIL Engineering Graduate with some experience in maintenance of track and track equipment for Railroad Department large Copper Company Chile, South America. 3-year contract. Transportation both ways and salary while traveling paid by Company. In reply give complete details. P-4384, Chemical Engineering.

(Continued on page 458)

**CONFIDENTIAL COUNSELLING**
**ON ALL**
**PERSONNEL PROBLEMS**
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In Salary Brackets $5,000—$50,000
**NATIONAL COVERAGE**

Please write briefly, outlining your specific experience or personnel needs.

*Wm. H. Bruce, Mgr.*
**EMPLOYMENT COUNSEL**
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# SEARCHLIGHT SECTION

*(Classified advertising)*

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$1.20 per line, minimum 3 lines. To figure payment count 5 average words as a line.
POSITIONS WANTED and Individual Selling Opportunity undisplayed rate is one-half of above rate, payable in advance.
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EQUIPMENT WANTED or FOR SALE Advertisements acceptable only in Displayed Style.

*Individual Spaces* with border rules for prominent display of advertisements.
The advertising rate is $11.80 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.
*An advertising inch* is measured ⅞" vertically on one column, 3 columns—30 inches—to a page.
NEW ADVERTISEMENTS—Address New York office, 330 W. 42 St., N. Y. 36, for the July issue closing July 3rd. C.E.

## PRODUCTION MANAGER

National AAA detergent manufacturer seeks fully qualified Production Manager. 40-50, good basic education in Chemical or Industrial Engineering or equivalent. Prefer ten or more years experience on all phases of production, including top management participation, in medium size company doing bulk and small unit high speed packaging of dry products. Excellence in human relations is a prime requisite. Salary open. If you are interested in a life-time career and excellent future with a multi-plant, growing concern, submit complete details in confidence first letter.

P-4544, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

## CHEMICAL ENGINEER

for plant development and production of

**DEFLUORINATED PHOSPHATES**

Extensive experience in all phases of calcining operations. Challenging opportunity for right man. Requires top level industrial background and executive ability to manage a plant.

Give complete details including references, salary requirements, and availability.

P-4241, Chemical Engineering
330 W. 42 St., New York 36, N. Y.

## PRINTED CIRCUIT ENGINEER

We require an engineer, electrical or chemical, experienced in printed carbon resistors to set up this process and take complete charge of developing printed circuits. Location, Virginia. This is an unusual opportunity with a successful and progressive components manufacturer. Our small engineering staff will grow considerably creating responsible positions for qualified men. Write your qualifications and salary requirements. All replies will be kept strictly confidential.

P-4546, Chemical Engineering
330 W. 42 St., New York 36, N. Y.

## INDUSTRIAL SALES DEVELOPMENT ENGINEER

Experience necessary with proven record to develop sales in Sterilization and Fumigation Fields. Background of training and experience should be in one of the following: Engineering, Chemistry or Biology. Must be willing to locate in North Western Pennsylvania. Submit complete resume of qualifications. Please state salary range expected.

P-4494, Chemical Engineering
330 W. 42 St., New York 36, N. Y.

## DESIRABLE PROPERTY

**Suitable for CHEMICAL & RELATED PROCESSES**
**Immediately Available at Sacrifice Price**

- 250,000 sq. ft. fully sprinklered.
- 60,000# steam per hr., Modern Boiler Plant, for Oil or Pulverized Coal, High Pressure.
- 5,000,000 gallons soft water daily.
- 300 Tons Refrigeration
- Completely fitted with Process Piping, Tanks, etc.
- Complete Air Conditioning Equipment.
- 7½ Acres completely fenced.

**Location: WOONSOCKET, R. I.**
For Full Particulars, Terms and Inspection

CONSOLIDATED PRODUCTS COMPANY, INC., as Agents
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*INVEST IN CUBA AND PAY NO INCOME TAX ON PROFITS OF FOREIGN INVESTMENTS*

FOR SALE

## HYDRATED LIME PLANT

- In CUBA with production capacity of 45 tons per day.
- Hydrated lime is indispensable in the manufacturing process of the sugar industry.
- Plant is situated in Center of largest sugar producing area in the world, with 37 large sugar mills within a few miles of plant.
- Own Railroad siding and with quarry with enough Limestone (Analysis 99.91 $CO_3$ Ca) for one hundred years.
- Plant is in production and has the most modern equipment. For complete details write:

BANCO AGRICOLA Y MERCANTIL
P. O. Box 342, HAVANA, CUBA
or—cable "AGRIMERCAN", Havana, Cuba, COLLECT.

Additional Business Opportunity advertising on page 458-460

## COMPLETE 4000 BARREL PER DAY

# REFINERY FOR SALE

**A complete small refinery, on a 59-acre site, connected with two railway lines, linked by highways with Central Canadian and mid-western United States cities and only 15 miles from Great Lakes system docks, is offered for sale. The plant, which is at Petrolia, Ontario, becomes available because its owners, Canadian Oil Companies, Limited, are now bringing on stream a much larger, ultra-modern refinery at nearby Sarnia.**

**In addition to full equipment to process crude oil into gasolines, lubricating oils, greases and by-products, the refinery has:**

- **30 buildings, the main units of which are of brick or reinforced concrete and with load-carrying walls;**
- **Adequate water supplies via town system from Lake Huron;**
- **Ample 60-cycle electrical power at low industrial rates from the Ontario Hydro-Electric Power Commission system;**
- **A central power plant, comprising two 500 HP water tube boilers.**

## REFINERY

**Newer sections include Flash Topping, Cracking, Reforming and Polymerization, and associated Treating units required by Universal Oil Products Company processes. They have operated under U.O.P. inspection and recording and U.O.P. engineers have advised on maintenance. Crude capacity is 4,400 barrels per day. Thermal cracking capacity is 1,200 B.P.D. and reforming capacity 800 B.P.D.**

**Steel tank storage capacity, above ground, is 375,243 barrels. A 4-inch pipeline connects the storage facilities with dockside on the St. Clair River.**

## BUILDINGS

**Total floor space of 80,000 square feet.**
**The office building, which also houses the plant laboratory, is a modern, well-built structure aggregating 9,000 square feet on two floors. Other buildings include:**

- **Garages**
- **Electrical Shop**
- **Pipefitting Shop**
- **Carpenter Shop**
- **Machine Shop**
- **Welding Shop**

**While built and operated as an oil refinery and efficient to process a relatively small crude oil throughput, the plant may be adaptable to other manufacturing processes.**

**Inquiries are invited and additional details can be supplied by:**

**Mr. G. S. Middaugh,**
**The Canadian Oil Companies Ltd.,**
**204 Richmond Street, West,**
**Toronto, Ontario, Canada.**
**Telephone EMpire 6-3031.**

**ENGINEERS**
**TEXTILE PRODUCTION MGR., $12,000**
**heavy exp. this line.**
**FACTORY MGR., $15,000**
**strong rubber b'kgr'd.**
**"Many fr. positions"**
**Call, write or wire: GLADYS HUNTING**
**DRAKE PERSONNEL**
7 W. Madison St. Chicago 2, Ill.

(Continued from page 457)

### SELLING OPPORTUNITY OFFERED

SALES REPRESENTATIVE wanted—Phenolic Resins. Willing to make commission arrangement if so desired. Our men have been advised about this advertisement. RW-4172, Chemical Engineering.

### EMPLOYMENT SERVICES

SALARIED POSITIONS $3,500 to $25,000. We offer the original personal employment service (established 42 years). Procedure of highest ethical standards is individualized to your personal requirements. Identity covered; present position protected. Ask for particulars. R. W. Bixby, Inc., 360 Dun Bldg., Buffalo 2, N. Y.

SALARIED PERSONNEL $3,000-$25,000. This confidential service established 1927, is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. B, 241 Orange St., New Haven, Conn.

### POSITIONS WANTED

ENGINEER: BSME, Registered P.E., Age 32, Married. 11 years diversified experience chemical industry—project and plant engineering, plant and equipment design, process calculations. Desires responsible position with increased challenge and recognition. Mid or Far West preferred. PW-4230, Chemical Engineering.

EXECUTIVE CHEMICAL Engineer — Registered PE, 50, with substantial experience in plant management and engineering in alkali and organic field. Excellent record of getting results. Seeks position of responsibility in plant management, multi-plant production supervision, engineering, or consulting organization. PW-3919, Chemical Engineering.

### SELLING OPPORTUNITIES WANTED

MFR. REP. est. 15 years desires additional power plant equipment accounts. Presently covering No. Ill. & No. Ind. industrials, contractors, laundries, etc. RA-4278, Chemical Engineering.

SALES ENGINEERING organization with established following in chemical, Pharmaceutical and allied industries, desires to represent additional processing equipment manufacturers in New York, New Jersey, Delaware and Pennsylvania. Commission only. RA-4453, Chemical Engineering.

### BUSINESS OPPORTUNITY WANTED

**For Sale—Janitor Supply**
and Chemical Business. Excellent reputation backed by 42 yrs. service in Pittsburgh area. Good net from last yr's $109,754 gross. Operations occupy 3 floors in 7-story, 267' x 111' brick bldg. $4,000 annual income from rental of remaining floors. Property valued at $175,000, equip. valued at $4,000 incl. with invty. & good will at $200,000. No. 2F-N3427. Chas. Ford & Assoc., Inc., Dept. 2046, 10 N. Clark, Chicago, Ill.

**AVAILABLE**
**EXECUTIVE CHEMICAL ENGINEER**
**Twenty years experience in petroleum and chemical industries. Project management; process, plant, equipment design supervision; construction; consulting; development new business.**
**PW-4466, Chemical Engineering**
330 W. 42 St., New York 36, N. Y.

**ADDITIONAL BUSINESS OPPORTUNITY ADVERTISING ON PAGES 457 & 460**

## WANTED
# ENGINEERS

***for Process Development in Electrical Wire and Cable plant in New Jersey***

Knowledge of the manufacture of insulated wire and cable essential. Knowledge of plastics also important for developing new processes and improving old ones. Must be able to help solve production problems including machine tooling, speeds and arrangements . . . improvise equipment when necessary . . . develop plastic formulations, mixing methods and recommend equipment for production mixing of plastics. Write stating age, education, experience and salary desired.

**P-4346,** Chemical Engineering
330 W. 42nd St., New York 36, N. Y.

## WANTED
## Assistant to Sales Manager

**Upper Michigan firm offers opportunity for man age 30-40 in capacity of Assistant to Sales Manager. Must be a chemical engineer with knowledge of industrial chemical business preferably copper chemicals. Must have selling experience. Will probably be located in large Ohio city to cover eastern and mid-west territory. Write giving qualifications and salary required to**

P-4440 Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

## CAREER OPPORTUNITY ON PERMANENT STAFF

If you are under 30 years of age, male, and have technical, industrial or sales background and writing ability, there is a position open to you.

This is an unusual opportunity to work with company management in the preparation of technical papers, sales and process promotion materials, industrial advertising, and house organs for a large national industrial corporation located in midtown New York City.

Please send details of your education, background, experience, and salary expected.

Reply confidentially to

P-4442, Chemical Engineering
330 W. 42nd St., New York 36, N. Y.




# Yes, Lockheed in California can train you – at full pay!

The step up to Aircraft Engineering isn't as steep as you might expect.

Aircraft Experience isn't necessary. Lockheed takes your knowledge of engineering principles, your experience in other engineering fields, your aptitude, and adapts them to aircraft work. You learn to work with closer tolerances, you become more weight conscious.

What's more, Lockheed trains you *at full pay*. You learn by doing—in Lockheed's on-the-job training program. When necessary, you attend Lockheed classes. It depends on your background and the job you are assigned. But, always, you learn at full pay.

These opportunities for engineers *in all fields* have been created by Lockheed's long-range production program—building planes for defense, planes for the world's airlines.

And remember this: When you join Lockheed, your way of life improves as well as your work.

Living conditions are better in Southern California. The climate is beyond compare: Golf, fishing, motoring, patio life at home can be yours the year 'round. And your high Lockheed salary enables you to enjoy life to the full.

**Note to Men with Families:** Housing conditions are excellent in the Los Angeles area. More than 35,000 rental units are available. Thousands of homes for ownership have been built since World War II. Huge tracts are under construction near Lockheed.

**Send today for illustrated brochure describing life and work at Lockheed in Southern California. Use handy coupon at right.**

**ENGINEER TRAINING PROGRAM**
Mr. M. V. Mattson, Employment Mgr.
Dept. CLE-6

**LOCKHEED**
**Aircraft Corporation**
Burbank, California

Dear Sir:

Please send me your brochure describing life and work at Lockheed.

My Name

My Field of Engineering

My Street Address

My City and State

PAGES from the GELB NOTE BOOK



CARCELY any single element in chemical engineering enjoys more top-level concentration than "the pilot plant". The new product or process, on paper or in the lab, gets grade-A attention from all departments. But when it comes to the pilot plant—it becomes an orphan.

"HOW soon can we get equipment? What will it cost? How long do we wait?" These and a thousand other questions must be answered.

WE, at GELB, have often undertaken the difficult task of equipping a pilot plant, for a wide variety of products. Mostly our efforts have been successful. Much pilot equipment installed by us has been a steady producer since its original date.

OUR idea in talking about this is to indicate our ability to provide equipment for pilot plants, as well as regular high-production equipment.

NATURALLY, a pilot plant based on used process equipment from GELB is noteworthy for low cost.

WE always have on hand a wide variety of usual and unusual chemical process equipment. See our list in our usual last page spot in this issue.

*Truly yours,*

*Edw. Gelb*



*I don't know what a pilot plant is, but I've met several pilots who gave me the loveliest flowers and lots of other things.*

*The Gelb Girl*

R. GELB & SONS, Inc.

STATE HIGHWAY No. 29 UNION, N. J.

UNionville 2-4900

AVAILABLE CUSTOM REFINING FACILITIES
- Distillation
- Extractions
- Separations
- Fractionations

Drum Lots—Tank Cars

WANTED
- All Types of Crude Mixtures
- By-Products, Residues, Wastes
- Contaminated Solvents

TRULAND CHEMICAL & ENGINEERING CO., INC.

Box 426, Union, N. J. UNionville 2-7360

Largest known deposit of
BARITE
Average 90 per cent BaSO4
Near Hailey (southern) Idaho
Complete report available
HARRY A. HERZOG
410 Henry Bldg. Portland 4, Oregon

SCREENED COKE

Small Coke, pea and nut size, for metallurgical and chemical plants; Screened Coke Breeze for industrial uses. Beehive oven coke; 48 hr. Furnace Coke; 72 hr. Low Sulphur Foundry Coke.

*Write for prices and freight rates.*

Deep Vein Connellsville Coal Co.
BRIER HILL 2, PA.

WANTED

CHEMICAL PLANT
WANTED

We are now manufacturing over $20,000,000 in various lines and wish to expand by acquisition of assets or stock of one or more industrial companies. In our negotiations the sellers' problems and wishes will receive full consideration. Present personnel will normally be retained.

Address all replies

"Confidential" C. J. GALE, Sec.
233 Broadway, N. Y. 7, N. Y. BA 7-1819

WANTED—SURPLUS
Dyes - Chemicals - Pigments
Plasticizers - Solvents
By-Products - Wastes - Equipment
CHEMICAL SERVICE CORP.
90-04 Beaver St. New York 5, N. Y.

WANTED
Vacuum Dryers, Heavy Duty Mixers, Reactors, Kettles, Columns, Rotary Filter, Pulverizers, Filter Presses, S/S and non-corrosive Tankage. Idle or Set Up Plant.
P. O. BOX 1351
Church St. Sta. New York 8, N. Y.

WANTED
BY-PRODUCT POTASH SALTS
LIQUID OR SOLID.
W-4083, Chemical Engineering
330 W. 42nd St., New York 36, N. Y.

BUY WITH CONFIDENCE
CONSOLIDATED PRODUCTS CO., INC., 2015 PARK ROW BLDG. NEW YORK 38, N.Y.
Phone: BArclay 7-0600 Cable Address: EQUIPMENT N. Y.
OLDEST AND LARGEST DEALER IN REBUILT PROCESSING EQUIPMENT

# "It pays to deal with a long established company"

## FILTERING EQUIPMENT

1—American Disc Filter 8' dia., 2 disc, 100 sq. ft. filtering area, with auxiliaries.
1—Shriver, iron steam heated, 30" x 30", 30 chambers.
4—Shriver & Johnson, 30 x 30 iron plate and frame, 35-40 chambers each.
1—8' x 12' Oliver Lead-Wood Vacuum Filter Acid-Resisting.
3—Oliver Vacuum Filters, incl. 8 x 12' 11'6" x 14', 11'6" x 18'.
1—ALUMINUM Sperry FILTER PRESS, 30 x 30", 45 chambers.
1—#12 Sweetland Filter, 36 leaves 4" c.c.
1—Kilby 39" x 39 CI Filter Press, open delivery, P & F, 48 chambers.
1—Sperry, 24" x 24" P & F Filter Press with 25 chambers, 2" frames.
1—Sparkler 33D12 with scavenger plate; 1—18D12 bronze, jacketed.
1—Filpaco 12" x 12" S/S, P & F, 12 chambers.
1—Bird-Laughlin 36" x 48" Rotary Continuous Filter; 2—18" x 28 Bird Solid bowl S/S.

## DOUBLE DRUM DRYERS

1—42" x 120" Buflovak Atmospheric, S/S Conveyors, S/S Elevator, S/S hood.
4—5' x 12' Buflovak Atmospheric.
2—32" x 90" Buflovak Atmospheric.
1—32" x 72" Buflovak Atmospheric.

## EVAPORATORS

1—Swenson Triple Effect, 1320 sq. ft. total, with copper tubes, steam pumps, condenser and piping.
1—Swenson Single Effect, copper tubes, 440 sq. ft., condenser, pump, etc.
1—Zaremba Single Effect, 54" x 16', Black Steel Body, copper tubes, 556 sq. ft. with Elliott Barometric Condenser.
1—Oates all copper Calandria, quadruple effect, 5,000 sq. ft. total, with separator, copper jet condenser and piping.
2—Buflovak, monel, double effect, 148 sq. ft. each effect.
4—Mojonnier S/S Vac. Pans, 3', 4', 5', 6'.

## BAKER PERKINS MIXERS

4—3000 gallon, size 30, type X-BS, welded.

## VIBRATING SCREENS

1—Battery of two 3' x 5' Tyler Hummer, Type 33, with Generator Set for both.
1—3' x 8' Selectro single deck.
1—3' x 8' Selectro double deck—rebuilt.
1—18" x 5' Selectro—rebuilt
1—Day #32 Rebolt, double deck, 20" x 38".
1—Day S/S single deck, 40" x 84".
1—Tyler "Rotap" Testing Screen, AC motor.

## EXTRAORDINARY OFFER RECENT PURCHASE

1—Devine #21 Vacuum Shelf Dryer, 13 shelves 59" x 78", Condenser and Pump.
6—Devine #28 Vacuum Shelf Dryers, each 20 shelves 59" x 78", surface condensers and vacuum pumps.
2—Ball & Jewell #2 Rotary Cutters.
1—Tolhurst 48" steel basket Centrifugal, suspended type, bottom discharge.
4—Traylor Tube Mills, 5' x 22', 5' x 20', 4'6" x 18'6", 4' x 13', each stone-lined, scoop feed, pebble charge, clutch pulley.
Still installed in one plant as operated, with all accessories as used.

## PULVERIZERS

1—5-roll Raymond High Side Roller Mill, #5057.
2—#5047 Raymond High Side Roller Mills, each complete with 50 HP, 3/60/2200 volt motors, connecting piping, etc.
3—Mikro Pulverizers, 2TH, 2SI, 4TH.
2—Smidth 5'6" x 20' Tube Mills, iron lined, each with Ball Charge and 3/60/2200 volt motors.
1—Allis Chalmers 4'6" x 7' Ball Granulator, iron lined. Used 100 hours.
1—6" x 15" Sturtevant Jaw Crusher, to ½".
1—24" x 15" Sturtevant Crushing Rolls, balanced type.

## DRY POWDER MIXERS

2—Kilby jacketed Horiz. Ribbon Mixers, 14' x 6'6" x 7', stuffing boxes, 450 cu. ft. capacity.
1—Howes 3,000#, double ribbon, 10' x 3' x 42".
1—Day Size F, 1850#; 1—Howes 1800# dbl. ribbon; 1—Munson Rotary 1,000# batch.
2—Burns 500# horiz. dbl. ribbon.

## DRYERS

2—6' x 50' Louisville Rotary Steam Tube.
1—4' x 8' Flaker or Cooling Roll.
1—5' x 23' Rotary Vacuum Dryer, jacketed shell; 1—28" x 8', jacketed, with dust collector and condenser.
2—5' x 40' Ruggles-Coles Direct Heat Rotary. Also Class A-2, 4' x 20'; Class XF-4, 54" x 25'.
2—Link Belt Rota Louvre, #207-10, #705-20.
1—5'6 x 24' Direct Heat Rotary Dryer or Kiln, welded shell.
1—Devine #7 Vacuum Shelf, 13 shelves, 40 x 43.
2—Buflovak Vacuum Drum, 5' x 10' with all accessories.

## PEBBLE MILLS

All porcelain lined

4—5' x 4', 235 gal.
3—6' x 8', 800 gal. porcelain and burr-stone lined.
1—Patterson, 24 x 36", 25 gal.
1—23" x 42", 125 gal.

## CENTRIFUGALS

2—42" ALL STAINLESS STEEL, Centrifugals. Amer. T & M Co. with S/S basket, curb, casing, shaft unloader and 40 HP variable speed Slip Ring 3/60/440 V 1200 RPM motor with full controls. Suspended, bottom discharge type.
1—Tolhurst susp. Centrifugal with perf. 40" MONEL basket. Bottom discharge, 2 speed, 20 HP 5 HP, 3/60/440 V Motor. All contact parts Monel.

## JACKETED KETTLES

1—Pfaudler glass lined 1000 gallon closed agitated Reactor.
1—1000 gal. Stainless Steel agitated.
1—1800 gal. closed agitated, 9/16", 140#.
1—5000 gal. steel agitated.
6—Dopp C.I. 80, 100, 150, 350, 600 gal.
7—Steel, agitated, 350, 500, 700, 800.
1—300 gal. S/S, 100#; 2 Lee 200 gal. S/S, 125#.
1—Dopp dbl. motion 100 gal.
2—700 gal. closed, with Simplex Turbo Mixers, reduction drive, m.d.
3—8500 gal., welded, agitated, open.
29—Aluminum, 50 to 500 gal., some agitated.
19—Copper, 25 to 800 gal.

## MUST MOVE

2—12,000 gal. Steel Storage Tanks, 8' x 32', ¼" plate. Fitted with manholes, safety vents, check valves, etc.

## MISCELLANEOUS

2—Buflovak 6' dia. Vacuum Crystallizers; 1—6' dia. Atmospheric, jacketed.
1—6' x 14' Hardinge Rotary Counter Current Classifier, also for dewatering or scrubbing.
2—Dorr two-stage Classifiers, each with two rakes, total length 27', gear reducer and motor.
1—Davenport #3A Dewaterer, with speed reducer and 5 HP AC motor.
1—Mechanical Cooker, 5' dia. x 16 long, jacketed, agitated. Insurance Certificate.
1—Capem S.I.F. Capper, with feeder.
1—Copper Rectifying Column, 6 sections, 30" dia. x 23' high, bubble cap type.
3—7' x 60' Rotary Kilns, equipped with roller bearings, gear reducers, motors, etc.
3—6' x 60' Vulcan Rotary Kilns, each with 3' x 30' Rotary Coolers, firing hood, all bases, complete.

**REMEMBER—We Buy Your Idle Equipment for Cash—Single Items or Complete Plants. Send us Your List**

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## OUR 35th YEAR OF SERVICE TO THE INDUSTRY

# Rebuilt For New Machine Accuracy
## *At Tremendous Price Reductions*

UNION Rebuilt Machinery Established 1912

International Stainless Steel Straightline Vacuum Filler, 160 per minute.
Resina S and LC Automatic Cappers.
Capem E4F 4-Head Rotary Capper.
Island Equipment Styline auto. Bottle Unscrambler.
CRCO New Way MH Wraparound Labeler.
S. & S. G1, G2, G6 Auger Fillers.
Stokes and Smith Model HG88 Duplex Auger Powder Filler.
Colton 2 and 3RP Rotary Tablet Machines.
Stokes 900 Tube Filler & Closer.
Stokes 2C Cream Filler and Closer.
Triangle Package Elec-Tri-Pak G2C, G2S, A2C, N2CA and A6CA Fillers.
Filler 4 Head Stainless Steel Filler.

Horix S. S. 14-head Rotary Filler.
Standard Knapp No. 429 Carton Sealer.
Mikro 4TH, 3TH, 1SH Pulverizers; Jay Bee U1, Schutz O'Neill Mills.
Tri-Homo #5 Colloid Mill, 7½ HP.
3500 gal. working cap. Steam Jacketed, Double Arm Mixing Tanks for mixing, storing or processing of your materials.
B. P. 150 gal. Unidor S. J. D. A. Mixer.
Stokes, Day, New Era, Hottman Mixers, from 2 to 450 gals., with and without Jackets, Single, Double Arm Agitators.
Baker Perkins and Readco Heavy Duty 5 to 150 gals. Double Arm Jacketed Mixers with Sigma or Fish Tail Blades.
Ross, Day, Pony Mixers, 8, 15 gal. caps.

Day, etc. 100 to 2500 lbs. Powder Mixers.
Acme 125 gal. S. S. Jacketed Mixing Kettle.
85 gal. S. S. Jacketed and Mixing Kettles.
Huhn Steam and Gas Fired Rotary Dryers.
Kent and Lehman 3 Roll Mills.
Allis Chalmers, Great Western Sifters.
Pony M, ML Labelrites; World Rotary Straightaway Labelers.
Pneumatic Scale Cartoning Line, 60 and 30 per minute.
Miller, Scandia, Hayssen Wrappers.
Campbell Auto. Cellophane Wrapper.
Package Machy. Co. FA4, FA Wrappers.

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318-322 Lafayette Street New York 12, N. Y.



# DRYERS AVAILABLE IMMEDIATELY

| Stock No. | Description |
|---|---|
| 3026 | Buffalo Rotary Vacuum Drum Dryer, 5'x12', chrome plated, with accessories. |
| D6-144 | Stokes Rotary Vacuum Drum Dryer, Model 59B; 40"x15'. |
| D6-145 | Stokes Rotary Vacuum Dryer; 24"x72". |
| D6-146 | Buffalo Rotary Vacuum Dryer, 5'x30', with accessories. |
| 1108 | Buffalo Vacuum Drum Dryer; 5'x12' Bronze Drum. |
| 1101 | Devine Vacuum Drum Dryer; 52"x10'6"; bronze drum. |
| 3414 | Rotary Drum Dryer with steam heated nickel drum; 48"x40". |
| 2877 | Bullovak Double Drum Dryer, 32"x72", with accessories. |
| 3310 | Bagley & Sewell Double Drum Dryer; 28"x80". |
| D9-103 | American Double Drum Dryer; 24"x60". |
| D9-104 | Buffalo Double Drum Dryer; stainless 32"x120". |
| D9-140/140 | Buffalo Double Drum Dryers; 42"x100" and 32"x120". |
| 3418 | Adt Class G Rotary Dryer, 2'x15, indirect gas heated. |
| 3364 | Squier Rotary Atmospheric Stainless Dryer; hexagonal shell; 30"x20'; Stainless Food and Aerofins. |
| 3188 | Louisville Counter Current Monel Lined Rotary Atm. Dryer, 30"x16'. |
| D11-156-6-7 | Louisville Rotary Steam Tube Dryers; 5'x28'; 6'x30'; 6'x35'. |
| D11-154 | Davenport Steam Tube Dryers; 5'x24'. |
| D11-150 | Huhn Direct Fired Rotary Dryer, 3'x12', with access. |
| D11-155 | Hersey Direct Fired Rotary Dryer, 3'x24', with access. |
| 3407 | Buffalo Vacuum Chamber Dryer with 20 shelves, 48"x42", with Vacuum Pump, Condenser, Receiver, etc. |
| 3289 | Stokes 16 Shelf Steam Heated Drying Cabinet; 3'x3'; with blower, motor, etc.; 6'10" overall. |
| 3053 | Procter & Schwartz Continuous Apron Dryer; 43'0" long; 7'6" wide; 14'6" high; apron width 3'; with accessories. |
| D6-147 | Procter & Schwartz Continuous Apron Dryer; 12 sections; 8 Passes with stainless woven mesh belt, 7'4 wide; 36' overall. |
| 3259 | Horizontal Dryers, 66"x14'7" with tracks, 2½" steam pipe, with capstan closing door each end. |
| 3102 | Horizontal Jacketed Dryer or Cooler; 54"x10' with agitator. |
| 3006 | Horizontal Steel Jacketed and Agitated Vacuum Cookers; 4'x7'7½" long. |
| 3382 | Rotary Vacuum Dryer, 52"x102" with agitator, dust collector, 10 HP motor. |

**SPECIAL**
**Buffalo 6' Jacketed Agitated Vacuum Crystallizer**

**FIRST MACHINERY CORP.**
157 HUDSON ST. WOrth 4-3900 NEW YORK 13, N. Y.



**PULVERIZERS:** Wms. LG 1, Raymond #1 w/cyclones. Sturt. #1 Ring. #1 Rotary—Wms. w/25 & 60 & 100 HP. Penna. w/125 HP.

**MILLS, HARDINGE:** 7' x 48", 5' x 22", 10' x 36" w/motors.

**CRUSHERS, JAW:** 8x11, 8x14, 12x20, 14x28, 16x22, 18x36.

**CRUSHERS, ROLL:** 12x12, 10x16, 30x16, 48x18, 54x24.

**KILNS, ROTARY:** 24" x 15' 4' x 30', 5' x 45', 6' x 80'.

**FILTER PRESSES:** Shriver 24" 28 PF. clsd. del.—30", 28 P & F, open wash, 36"—62 Recsd. Pl. open-wash.

**VACUUM PUMPS**—Devine 10 x 10, I.R. 4 x 4 x 2-¾ w/motors.

**CRANE**—Nthn. Eng. 43' span, 10 ton A.C.

**COOL BREEZES**—40 Exhausters to 40000 cfm.

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**FOR SALE**
1—42" x 16" Allis-Chalmers crushing rolls.
1—36" x 15" Sturtevant crushing rolls.
2—24" x 16" Rogers crushing rolls.
1—6' Raymond Whizzer separator.
15 Tons of 1½" to 2" Manganese Steel balls.
81½' x 60', 7½' x 60', 7' x 60', 6' x 60', 5' x 30', 4' x 36' and 3' x 30' dryers.
New dryers and kilns.
**W. P. HEINEKEN**
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**STEEL STORAGE TANKS**
18—8000 & 10,000 Gal. R.R. Tanks.
4—20,000 gal. New 5/16 Inch Horiz.
22—10,000 & 15,000 Gal. ½ Inch Horiz.
9—2500, 5000 & 10,000 Bbl. Vert.
**L. M. STANHOPE, Rosemont, Penna.**



**WOOD TANK FOR SALE**
8'4" Diameter x 12' high. 2" white cedar staves. 10¾" hoops, lugs and nuts. Four 4x6" long leaf yellow pine dunnage. Two 4" galvanized outlets. One 2" galvanized drain.
**TELL MANUFACTURING CO., Inc.**
**200 South Jefferson St., Orange, N. J.**



**MOTORS, GENERATORS, TRANSFORMERS**
**1 — 1500 H.P**
**Bought and Sold New and Rebuilt**
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## DRYERS—KILNS

1—9'6" x 8'6" x 200'-¾" shell, 4-16" tires complete.
1—8' x 135'-½" shell, 2-14" tires, complete.
1—8' x 115'-½" shell, 2-14" tires, complete.
1—8'6" x 100'-½" shell, 2-14" tires, complete.
1—10' x 90'-9/16" shell, 2-14" tires, complete.
1—8'6" x 83'-½" shell, 2-16" tires, complete.
1—6' x 80'-¾" shell, 2-8" tires, complete.
1—Link Belt 11'6" x 35' Roto-Louvre with hoods, blower, etc.
1—Link Belt 2'7" x 8' monel Roto-Louvre, coils, fan, etc.
6—Rotary Dryers 7' x 70', 7' x 60', 5' x 67', 4'6" x 40', 4'6" x 25', 4' x 20'.
4—Louisville Rotary Steam Tube Dryers 6' x 50', 6' x 30', 4'6" x 25'.
3—Buflovak 30, 15, 7 and 5 Shelf Vacuum Dryers 42" x 42".
5—Stokes & Buflovak Rotary Vacuum Dryers 38" x 8', 3' x 15', 5'6" x 38'.
1—Shaw-Knox Stainless Steel Rotary Vac. Dryer 42" x 8'.
1—Buflovak 32" x 100" Atmos. Double Drum.
1—Single Drum 66" x 80" Flaker.
1—14 Truck steam heated Dryer 1680 sq. ft.
3—Devine 17 shelf double door Vacuum Dryers 39" x 78".

## FILTERS

6—Vallez Pressure Filters 360 and 540 sq. ft.
2—Sweetland #12 with 36 and 72 leaves.
1—Sweetland #7 with 27 steel leaves.
8—Oliver Rotary Vacuum 11'6" x 14', 8' x 12', 8' x 10', 8' x 8', 3' x 4', 3' x 1'.
3—Eimco Rotary Vac. 8' x 8', 4' x 5', 4' x 4'.
1—Oliver Rotary Vacuum Pressure Filter 3' x 4' steel.
1—Oliver 6' x 6' Rotary Precoat Filter, rubber-lined.
1—Feinc Rotary Vacuum 8' x 12' steel with drive, etc.
2—Kilby 42" P&F, cast iron, 55 chambers, 2".
4—Shriver 36" P&F, 30 chambers, C.I., open delivery.
1—Sperry 36" Recessed, 48 chambers, C.I., open delivery.
5—Shriver 30" P&F, 30 chambers, C.I., open delivery.
8—Sperry 24" P&F, 16 chambers, C.I., closed delivery.
1—Shriver 24" Recessed, 30 chambers, C.I., open delivery.
3—Shriver 18" Recessed, 30 chambers, C.I., open delivery.
2—Sperry Aluminum 30" and 24" P&F, 22 and 26 chambers.
1—Shriver Aluminum 12" P&F, 6 chambers.

## CENTRIFUGALS

1—Bird 48" suspended, bottom discharge, steel perforated.
1—Tolhurst 48" Center Slung S.S., perforated basket.
1—AT&M 42" Suspended S.S., bottom discharge, perforated.
6—AT&M 40" Bronze Baskets, bottom discharge, perforated.
1—Fletcher 40" Suspended, Bottom Discharge, S.S., perforated basket.
2—Sharples C27, C20, 316 S.S. Super-D-Hydrators.
1—Tolhurst 32" Suspended Monel, bottom discharge, perforated.
2—Bird 36" x 50" solid bowl, stainless.
1—Sharples P14 S.S. Super-D-Canter.
4—Sharples #18 S.S. and steel.

## PULVERIZERS

3—Raymond 5 roll, 4 roll High Side Mills complete.
1—Bauer 28" Attrition Mill 2—50 HP motor.
17—Patterson, Abbe Pebble & Ball Mills 40 to 1000 gals.
2—Premier Colloid Mills 8" dia., S.S.
1—Eppenbach QV7 Colloid Mill.
2—Jeffrey 36" x 24", 20" x 12" Hammer Mills.
2—Raymond 12', 4' Air Separators.
1—2 Roll Rubber Mill 6" x 12".
2—Mikro No. 1SI Pulverizers, 5 HP motors.
1—No. 6 Mikro Atomizer, S.S., 20 HP motor complete.
1—Fitzpatrick Comminuting Mill 5 HP.

## SCREENS

1—Selectro S.S. double deck 4' x 10'.
5—Sprout Waldron S.S. single deck, 40" x 84".
1—Robinson, Rotex Single Deck 40" x 84", 40" x 104".
1—Tyler Hummer 4' x 7' Single Deck.
5—Tyler Hummer 3' x 5' Triple Deck.
1—Abbe #2 Blutergess Sifter.

## MIXERS—ALL TYPES

7—Baker Perkins 200, 100, 30 and 9 gals., jacketed, double arm, sigma blades.
1—Baker Perkins 300 gal. Unidor S.S.
1—Baker Perkins 2 gal. Stainless.
1—Day 100 gal. Cincinnatus jktd, double arm.
1—Day 30 gal. Imperial jktd, double arm.
10—Day 200# to 3000# Powder Mixers.
12—Electric Portable Agitators ¼ HP to 5 HP, NEW.
4—Day, Boss, 8 and 50 gal. Pony Mixers.

## MISCELLANEOUS

20—Bucket Elevators, steel housings, 34' to 90' centers, 8" x 5" to 24" x 8" buckets.
7—Stokes Vacuum Pumps 15 to 100 CFM.
1—Milton Roy Proportioneer Pump, S.S. and Hastelloy, 10 GPM.
5—Devine, Buflovak Condensers and Receivers, 20 to 90 sq. ft.
7—Groen 150, 125 gal. Stainless Steel, jacketed, agitated, kettles.
4—Stokes DD2, D4 Rotary Tablet Machines.
5—38" dia. Stainless Steel Revolving Pans.
1—Nash Hytor Vacuum Pump 440 CFM.
10—Olivite Duriron & rubber Centrifugal Pumps, 1½" to 4".

## SPECIALS

1—9'6" x 200', ¾" shell, Rotary Kiln, 4-16" tires complete.
1—8' x 125', ¾" shell, Rotary Kiln, 2-14" tires complete.
2—Oliver monel 8' x 10' Rotary Vac. Filters.
1—Rogers Spray Dryers 16' dia. with all accessories.
4—Pfaudler 100 gal. glass-lined Stills with condensers, receivers
4—Steel 2000 gal. jacketed, agitated, 200 psi Reactors.
1—Pfaudler 350 gal. glass-lined, jktd. agitated Reactor.
3—Dopp 250, 150 gal. jacketed, agitated kettles.
5—Steel Storage Pressure and Acid Vessels 3500 to 20,000 gals.
1—Quadruple Effect Evaporator, brass tubes 16,000 sq. ft.
1—Buflovak VRC, stainless steel Single Effect Evaporator 94 sq. ft.
1—Buflovak VRC, Triple Effect Evaporator, 963 sq. ft.
1—Buflovak 6' dia. Vacuum Crystallizer.
2—NEW Absorption Towers, 13,500 gal. cap.
10—Steel Tanks 9000 to 100,000 gals.
12—Tubular Condensers 200 to 1600 sq. ft.

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"A SINGLE ITEM OR A COMPLETE PLANT"

## QUICK DELIVERY ON GUARANTEED EQUIPMENT

### Large Stock at our Brooklyn Warehouse & Shop

**DRYERS & KILNS**

Devine #12 Vac. Shelf Dryer, 40"x42" shelves.
Lyden elec. single truck Dryer 600°F.
2—Ruggles Coles 7½' x 60' & 6' x 45' Rotary Dryers.
1—Allis-Chalmers 10' x 50' Rotary Kiln.
1—Ruggles Coles 54" x 28' Rotary Dryer.
New Rotary Dryers, Kilns & Coolers built to order.
2—Proctor 6 fan pneumatic Conveyor Dryers.
2—Albright-Nell 4' x 9' Atmos. Drum Dryers.
1—Buffalo Vac Drum Dryer 24' x 26'. Also Rotary Vac. Dryers & Vac. Shelf Dryers.
6—Steam, Gas & Electric Dryers, Tray & Truck.

**CENTRIFUGALS & CENTRIFUGES**

5—Tolhurst 40" Suspended Type Centrifugals. Bottom Discharge. Motor Driven.
6—Centrifugals 20", 30", 40" & 48", Steel, Copper, Stainless & Rubber Lined.
12—Sharples Centrifuges #5A Stainless. Also #6.
3—De Laval Multiple Clarifiers #200, 300 & 301.

**FILTERS**

1—Vallez 41 Stainless Covered Leaf Filter, type 40.
10—Sperry & Shriver 12", 18", 24", 30", 36" Iron Filter Presses.
1—12" Bronze Filter Press.
Sweetland & Oliver Rotary Vac. Filters.

**KETTLES & TANKS**

Devine 36" dia. Improv. Unit, closed Jack-Liquor & Improv. Kettles. Also 100 gal. size.
1—Steel ASME 275 PSI Pressure Tank. 1200 gals.
Devine 1000 ea. closed jack agit. steel kettle.
6—Jacketed Kettles 50 to 2500 gals.
1—250 gal. Lead Lined Kettle.
1—1000 gal. Stainless Agitated Tank.
6—Pfaudler 1000 & 500 gal. vert. Glass Lined Tanks.
2—Pfaudler 250 gal. Glass Lined Agit. Jack Kettles.
New Stainless Steel Tanks 50 to 500 gals.
30—Stainless Alum., Copper, Glass & Lead Lined Kettles & Tanks. Also new Stainless.
6—Copper Varnish Kettles 150, 200 & 300 gals.

**PULVERIZERS & MILLS**

#1 Raymond Automatic Pulverizer 20 H.P. motor.
1—Raymond #00 Pulverizer 30 HP. Complete.
1—#0000 Raymond Mills.
6—Hammer Mills & Pulverizers 3 to 50 H.P.
1—Schutz-O'Neill 20" Pulverizer. Also #1.
1—Sturtevant 30" Rock Emory Mill.
1—Robinson 22" Attrition Mill.
1—Lehman 4 Roll W. C. 12" x 30" Steel Mill.
5—Lehman & Kent 3 Roll Steel Mills.
8"x22", 9"x32", 12"x36" & 6"x40".
1—6" x 36" Double Steel Roller Mill.
1—6" x 24" 3 pr. high steel Roller Mills.
3—Hoochin 18" x 36", 4 Roll Granite Stone Mills.
2—Abbe Pebble Mills, 6' x 8', & 3'9" x 42".
6—Abbe Jar Mills Lab to 25 gal. sizes.
Ball & Jewell & Leominster Rotary Cutters.
1—U. S. Colloid Mill 15 HP Motor.

**MIXERS—ALL TYPES**

Baker-Perkins heavy duty double arm Mixers, 100, 50, 9 & 4½ gals. motor driven.
Horix Mixers single & double arm to 200 gal.
Day & Roe 40 & 15 gal. Pony Mixers.
1—Century 2 HP, 4 speed Vert. Mixer.
6—Lead & Paste Mixers 50 to 150 gals.
Patterson 30" dia. Stainless Conical Blender.
1—Master Drum Type Blender 1000#.
Lancaster #3 Pan Mixer 7½ HP. M.D.
10—Dry Spiral Mixers 50 to 2000 lbs.
12—Portable Elec. Liquid Mixers ¼ to 3 HP.

**MISC. & SPECIALS**

1—200 Ton Brunswick 16" upstroke Record Presses.
1—French Oil Linseed & Cottonseed Hydr. Presses.
1—Goulds 75 HP, 2 stage motor driven Centrifugal Pump. 250# WP.
6—French Oil Motor Driven Expellers.
New 6" x 12" Lab Mixing Mills & Calenders.
6—Farrel 18" x 36", 18" x 48" & up to 22" x 60" 2 Roll Mixing Mills.
3—Rubber & Plastic Extruders 1" to 6".
1—Stokes 2E Paste Filler up to 5 gal.
1—Marco #200 Stainless Steel Homogenizer.
1—Stokes & Smith & Day Powder Fillers.
6—Filling Machines, Liquid, Paste & Powder.
Rotary & Single Punch Tablet Machines, ½" to 3".
2—Howe Mogul Barrel Bag Packers.
2—Revolving Pans 36" & 54".
6—Stokes Vert. High Vac. Pumps.
2—Worthington 12" x 12" x 12" Vac. Pumps.
6—Devine & Buffalo Vac. Pumps.
Soap Machinery for Toilet Laundry Chip Liquid.
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## STEIN EQUIPMENT COMPANY

90 West Street, New York 6, N. Y. Cable Machequip



**CLASSIFIERS:** 6—Akins and Wemco 24" and 78", single screw, double pitch, weir type 220/440 volt motors, all in new condition. Three of the above located near Reno, Nev. 2—Dorr 8' x 35' rake, one with 18' and one with 22' bowl. New condition.

**DRYERS or KILNS:** 2—10 ft. x 90 ft., heavy duty, with or without auxiliary equipment, condition like NEW. One located in Minneapolis. 1—Kiln 4 ft. dia. x 65 ft., complete with all equipment, oil fired, like NEW.

**FILTERS:** 2—Oliver acid resistant, 14 x 10' drum Filters with steel tank, with all auxiliary equipment, including compressor, vacuum pump, motors, speed reducers, etc. Condition like new. One located on west coast.

**AIR SEPARATORS:** One Bradley and one Sturtevant 10 ft., with or without 100 H.P., 440 volt, motor.

**PULVERIZERS:** Hardinge Mill size 5 ft. x 22", steel lined, complete with disc feeder and 30 H.P. motor. 1—5' x 22", silica lined. 1—Sturtevant 1-½ Ring Roll Mill. 1—3' x 4' Elmco Ball Mill complete with liners, ball charge, V-belt drive and 20 H.P. motor and control, NEW condition. One Marcy Rod Mill 5' x 12' and one 5' x 14', manganese lined, with motors and drive.

**REDUCTION CRUSHER:** Symons 8-½ ft. Cone, short head, fine bowl, V-belt, 200 H.P. motor and control.

**COMPRESSORS:** Worthington DC2, 29/18-½ x 21, 600 H.P. synchronous motor, 440 volt, with all auxiliary equipment. 4—Ingersoll Rand Diesel portable, 500 cu. ft. @ 100 lbs. pressure. NEW 1951.

**MONORAIL CRANE:** 3 tons capacity, 90 ft. runway, 1 yd. Hayward motor driven steam shell, 220 volts, D.C.

**OVERHEAD ELECTRIC TRAVELING CRANE:** 44 ft. span, 4 motor, 220/440 volt, 55 ton capacity.

**STEEL BUILDING:** 362 ft. long, 36 ft. wide, 15'9" inside, corrugated aluminum sides and roof.

**BOOT BUCKET ELEVATORS:** 2—Fully enclosed Chain Bucket Elevators 24' x 48" x 40' centers, buckets 9" x 12" x 7" deep, links 2-½" x 4", bucket to bucket center 10", with 10 H.P. motors and speed reducers, 220/440 volt, A.C.

**SCREW CONVEYORS:** 1—10" x 10' and 1—16 x 12', complete with motors, reducers, etc.

**ELECTRIC HOIST:** Single drum, 3' dia., 2'6" face, 75 H.P., 230 volt, motor, Herringbone gears. New condition.

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**New SS Reactors From 50 gals. Up**
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**New & Used SS & Steel Ribbon Blenders**
**— all sizes —**

120" Rotary Kiln—Complete
Buffalo Vac. Shelf Dryers 30" x 42" Complete
Mikro #6 Atomizer Complete—20 HP Motor
Bowen SS Spray Dryer—7' x 9'-5" Complete
Steel Reactor—300 gal.—200 PSI—Complete
Abbe Belgian Block Lined Mills 5'x6' & 4½'x3'
Simpson Intensive Mixer Size "0"
B & J Rotary SS # 1½ Cutter 40 HP

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## EQUIPMENT CLEARING HOUSE, INC.

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## Charlotte-Colloid Mill No. 20

**Cast Steel Rotor and Stator**
**Complete with motor. Used only a few hours.**

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**—Prompt Shipment—**

**GLASS LINED TANKS — USED**—3000 gallon capacity. Welded construction—Fully insulated. Equipped with manhead. Suitable for milk, food products, lily white chemicals, solvents and fine lacquers.

**VARNISH TANKS—USED**—54" diameter x 14'6" high (or long) ⅜" Steel — Welded construction — 1700 gallons.

**MISCELLANEOUS TANKS**—Various sizes and types.

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**LURIA STEEL & TRADING CORP.**

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**Chicago 4, Ill.**
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## CENTRIFUGES FOR SALE

1—Tolhurst—12"—Rubber Covered—Laboratory Centrifuge, Center Slung.
1—A.T.&M.—30" Stainless Steel—Centrifuge—Base Bearing.
1—Tolhurst—36"—Steel, Center Slung Centrifuge.
1—A.T.&M.—40"—Rubber Covered Centrifuge Link Suspended.
2—Fletcher—40"—Bronze Center Slung Centrifuges.
2—Tolhurst—40" Bronze Center Slung Centrifuges.
1—Fletcher—48" Bronze Center Slung Centrifuge.

*Most of the Above have Motors.*

FS-4551, Chemical Engineering
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## COLUMNS—STILLS

2 Aluminum Bubble Cap Columns, 36" dia. x 45 plate.
1 Aluminum Bubble Cap Column, 27" dia. x 10 plate.
1 Aluminum Perforated Plate Column, 28" dia. x 36 plate.
1 Copper Bubble Cap Column, 42" dia. x 31 plate.
1 Copper Bubble Cap Column, 30" dia. x 22 plate.
1 Copper Column with 18—30" dia. perforated plates and 19—24" dia. bubble cap plates.
1 Copper Sieve Plate Column, 30" dia. x 22 plate.
1 Copper Perforated Plate Column 24" dia. x 14 plate.
1 Steel and Cast Iron Bubble Cap Column, 30" dia. x 62 plate.
1 Steel Bubble Cap Column, 9 plates 10' dia. and 19 plates 8'4" dia.
1 Stainless Steel T316 Raschig Ring packed column, 24" dia. x 6'8" high.
1 Stainless Steel T316 direct fired Vacuum Still, 325 gal.
2 Copper Vacuum Stills, 48" dia., jacketed and agitated.

## CONDENSERS—EXCHANGERS

3 Aluminum tub. 166 sq. ft.
6 Copper tub. 65, 75, 95, 330, 420, 487 sq. ft.
1 Stainless Steel tub. 39 sq. ft.
1 Stainless Steel Tube Bundle, 180 sq. ft.
4 Stainless Steel Coil Condensers, 40 sq. ft., 60# pr.

## DRYERS—EVAPORATORS

1 Louisville Rotary Steam Tube Dryer, 5' dia. x 30'6" long; with screw press.
1 Pan Dryer or crystallizing Kettle, 10' dia. x 3' deep.
1 Stokes #59A Jacketed Vacuum Rotary Dryer, 18" dia. x 42" long.
2 Atm. Double Drum Dryers, 22" x 38".
1 Cummer Rotary Hot Air Dryer, 48" dia. x 26' long.
1 Struthers Wells Evaporator, 100 sq. ft. tube bundle.
1 Copper Vacuum Evaporating Pan, 6' dia., jacketed.
2 Copper Vacuum Pans, 4' dia., jktd. & agit.
1 Pfaudler 60 gal. Glass Line jacketed Evaporating Dish.

## FILTERS

2 #10 Sweetland.
1 #3 Sweetland, 11 leaves, 3½" centers.
1 Rotary Vacuum Iron, 6' dia. x 3' face.

**1 Swenson Rotary Continuous Vacuum Filter; Precoat type, 8' dia. x 8' face, rubber covered and lead acid proof construction.**
**1 FEINC Rotary Vacuum Filter, string discharge, 4'6" dia. x 6' face, aluminum.**

1 Ertel Bronze Disc Filter, EX-40; 80 sq. ft.
4 Pressure Leaf Filters, 70 to 80 sq. ft.
2 Industrial P. & F. Mfg. Co. Pressure Leaf Filters, Type RB, size 18x48, 68 sq. ft.; rubber lined tank, bronze leaves.
13 Filter Presses, Cast Iron:
4 Shriver 36" rubber covered, closed dely., washing.
1 Shriver 30" rubber covered.
1 Shriver 30", 35 rec. pl., open dely.
1 Shriver 24", 40 ch., open dely., wash.
1 Shriver 24", 24 ch., closed dely.
1 Sperry 24", 15 rec. pl., open dely.
1 Shriver 24", 28 ch., closed dely.
1 Shriver 24", 23 ch., cl. dely., wash.
1 Shriver 24", 12 ch., cl. dely., wash.
1 Johnson 18", 6 ch., closed dely.
2 Sperry 10", 1 ch., closed dely.
2 Louisville 8-roll Continuous Grains Presses, 24" and 36" wide.

## KETTLES—REACTORS

**1 Paterson 10 gal. Inconel Pilot Plant Reaction Kettle, Jktd. & Agit. with Dowtherm unit.**

1 Stainless Steel, Type 347 Autoclave or pressure tank; 150# pr., Elec. heated 850° F; 17¼" dia. x 9' high.
70 Stainless Steel and Stainless Clad open top, steam jacketed kettles—10, 45, 60, 80, 100, 150, 250, 500 gal. sizes.
1 Stainless Steel Kettle, 950 gal., 20# jkt. pr., vertical agitator, Type 347 shell, bolted C.I. top.
2 250 gal. Stainless Steel Steam Jacketed Kettles, open top, with double motion agitators.
2 150 gal. Stainless Steel Steam Jacketed Kettles, open top, with double motion agitators.

**1 200 gal. Read Stainless Steel Jacketed Kettle, open top, double motion agitator, 10 HP motor.**

1 3000 gal. Horiz. Steel Cooker, Vacuum, Agitated.
1 2000 gal. Vertical Steel Cooker, agitated.
2 Vertical Steel Cookers, 90# int pr., 1260 gal., 1660 gal.
2 1500 gal. Vertical Jacketed Steel Kettles, 100# int. pr., 80# jkt. pr.
3 100 gal. Vertical Jacketed Agitated Steel Kettles, closed, for pressure or vacuum.
1 Lead Lined Kettle, 500 gal., closed top, with coils, jacket & agitator.
1 Aluminum 180 gal. Reaction Kettle, jktd. & Agit.
1 300 gal. Aluminum Jacketed Kettle, open top.
1 Glass Lined Kettle, jktd. & Agit., 50 gal.
1 6000 gal. Copper Brewing Kettle, agitated.
2 Copper Jacketed Agitated Vacuum Kettles, 4' dia. x 4' deep, double motion agitator.

## MILLS—PULVERIZERS

2 Paul Abbe #8 Pebble Mills, porcelain lined, 32" x 36".

**1 Hardinge Conical Ball Mill, Steel Liner, 4'6" dia. x 24" long.**

3 Sprout Waldron Attrition Mills, double disc—sizes 16 and 30.
1 Williams Hammer Mill, type AK; size A, stainless steel.
2 Williams Size 1 Hammer Mills.
2 Schutz O'Neill Style D Pulverizers, 18" and 23".
1 Mikro Pulverizer, #2-SI.
1 Fitzpatrick Model "D" Comminuting Machine, Stainless Steel.
1 Premier Colloid Mill, type U-3, 6" st. st. rotor.

## MIXERS—AGITATORS

1 Porter heavy duty jacketed double worm mixer—75 gal.
1 Dellenberger 100 gal. Heavy Duty Double Arm Mixer, fish-tail blades, jacketed.
2 Stokes Granulating Mixers, 100#.
1 Read Co. Horiz. Ribbon Type Mixer. Jacketed, 600#.
8 Horiz. Ribbon Type Powder Mixers, 50#, 100#, 200#, 400#, 600# & 2000#.
1 Broughton Powder Mixer, double arm, 50 cu. ft.
10 Copper Conical Blenders, ½, 1, 7 & 11 cu. ft.
1 Turbo Mixer, #3B, with 7½ HP motor.
7 Vertical Gear Motor Agitator Drives, 1 HP 3/60/220-440/60 RPM.
2 Lightnin Vertical Agitators, 33-B-300, 3 HP 1150 RPM, Expl. Pr. Flange mounted; packing glands.
1 Paterson Side Entering, stainless steel, 10 HP motor.

## TANKS

3 Aluminum Tanks, closed, 500 & 1350 gal.
1 Aluminum Tank, 45,400 gal., New, 12' dia. x 50' long. Can be furnished as 2—12' dia. x 25' long tanks.
2 100 gal. Glass Lined Vacuum Tanks.
22 Horiz. Welded Steel Tanks, Lastiglas Lined, 15,200 gal.
3 Horiz. Welded Steel Tanks, Lastiglas Lined, 5800 gal.
4 Vertical open top Welded Steel Tanks, Lastiglas Lined, 3500 and 6000 gal.
18 Vertical Welded Steel Tanks, closed Mammut Lined, 7700 gal., 7000 gal. & 2300 gal.
1 Steel Yeast Tank, 2050 gal., copper coils.

**5 Vertical Jacketed Pressure Tanks—steel—30# steam jacket—6mm vacuum internally:**
**3—34" ID x 13' H (approx. 700 gal.)**
**1—23" ID x 10' H (approx. 230 gal.)**
**1—23" ID x 9' H (approx. 195 gal.)**

1 Vertical Rubber Lined, 6000 gal.
1 Vertical Lead Lined with coils, 200 gal.

### STAINLESS STEEL TANKS IN STOCK

1 16,200 gal. Vert., closed, T304—NEW
1 5700 gal. Horiz., T302—NEW
1 4200 gal. Vert., closed, T304—NEW
1 2350 gal. Vert., open, T302—NEW
1 1400 gal., Vert., open, 10' L x 57" W x 57" D
2 1000 gal. Vert., T304—NEW
2 500 gal. Vert., T304—NEW
40 Stainless Steel Tanks—from 6 gal. to 450 gal. sizes.
2 3000 gal. Horizontal Stainless Steel Tanks, 5'4" dia. x 18'9" long, insulated and agitated. Excellent for transporting, storage or holding.

## MISCELLANEOUS

3 Welded Steel Bins—1884 & 4800 cu. ft.
2 Ingersoll Rand Type FS-538 Meter-Blowers 4000 CFM at 2 lb. pr.
2 DeLaval #600 Centrifugal Oil Purifiers.
1 Bird Suspended 48" Steel Centrifugal, Perforated basket; Bottom discharge.
1 Fletcher 30" Jr. Centrifugal Extractor, St. St. Imperf. basket.
1 Sharples #16 Super Centrifuge, stainless steel.
1 Spencer Turbine Co. Gas Booster or Compressor, stainless steel, 30 HP motor, 600 CFM at 80 oz. pr.
1 Deionizing System, 500 GPH. Zeolite.

**2 Kux Machine Co. Model 23 Rotary Pellet Presses, 21 and 23 punch—with motor and vari-drive.**

6 Stokes Rotary Pellet Presses, 18 punch, B-2, D-3, D-4.
1 Byron Jackson Deep Well Pump, 150 GPM 325' head, NEW.
1 Ingersoll Rand Bronze Centrifugal Pump #5ALV, 40 HP, 850 GPM at 140', NEW.
2 Ingersoll Rand Bronze Centrifugal Pumps, #11½-RVH, 20 HP motor, 200 GPM at 230'.
12 Aurora Bronze Turbine Pumps, H-5, G-6, H-6, NEW.
3 Selecto Vibrating Screens, stainless steel, 2' x 7', double deck, enclosed.
1 Stainless Steel Horizontal Sterilizer or Steam Retort, 10# pr., 24"W x 26"H x 36"L.
1 Stokes Vertical Steel Jacketed Vacuum Chamber and Impregnating tank, 30"L x 24"W x 24"D.

**STAINLESS STEEL FABRICATION**
**We have in stock a quantity of Stainless Steel sheets: Type 304—12 ga., 14 ga., and 10 ga. Tanks, receivers, etc. fabricated to your specifications.**
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### CHOICE EQUIPMENT—MOSTLY NEW IN 1951

Proctor & Schwartz Conveyor Type Apron Dryer; length overall, 76'2"; length of main body, 60'7"; width overall, 13'1"; width of main body, 11'10"; height overall, 12'8"; height of main body, 7'11½"; effective width of STAINLESS STEEL perforated belt, 7'-3-½" traveling at speeds of 21 to 84 minutes through dryer. Equipped with ten turbine type circulating fans, 5000 CFM each, plus three exhaust fans. Heating 1038 Ft. of 1" corner finned pipe and 1557 Ft. of 1" steel finned pipe. Stainless Steel Oscillating Granulator at Feed end of Dryer . . . complete with all controls and operating instruments still set up where originally used.

Oliver Rotary Vacuum Filter with wood drum 11'6" x 12' open type with steel agitated trough. Koch Electric Ovens, tray type; chamber is 58" wide, 69" deep and 72" high; with controls. Battery of Suspended Type 40" Centrifugals; perforate baskets; overhead driven by 7½ H.P. motor; made by Western States (Roberts); solid spindle, ball bearing heads; self discharging Productive Equipment Co. Selectro Screen 4' x 12'.

2 Locomotive Type Fire Box Steam Boilers, 107 H.P. and 150 H.P.
2 Fitzpatrick Model D Stainless Steel Comminuting Machines, with 3 HP. and 5 H.P. motors.

**REDWOOD TANKS with AGITATORS**

| Gal. | Dia. | Ht. |
|---|---|---|
| 2,500 | 8'6" | 7' |
| 5,000 | 11' | 8' |
| 10,000 | 13'9" | 10' |
| 20,000 | 18' | 12' |

Steel Storage Tanks up to 20,000 gals.
2 Installations of Roller Conveyor, each 350'.
Numerous Belt Conveyors, varying lengths, 24" wide.
COMPLETE LAMORATORY, fully equipped.
Rotary Dewatering Screen or Trommel, 42" x 19'8".

**MISCELLANEOUS**

Pumps: Centrifugal Pumps, 1½" and 2½", Caustic Pumps, Bronze Rotary Pumps, with suitable motors.
Motors: 2 Induction Type, 15 H.P.; 5 Induction Types, 10 H.P.; Agitator Drives, Reduction units.
Scales, Suspension Hoppers, Scale Hoppers, Fork Type Lift Truck, Budget Hoist, Air Compressors, Air Washers, Dehumidifiers, and miscellaneous stand by material.

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1—Eppenbach Stainless Steel Home Mixer, complete with a 7½ HP Explosion-Proof Motor.
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HIGH SPEED Roller Mills 9"x24" to 15"x40".
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2—70" x 35' Ruggles Coles A-10.
Single Shell: 4x20, 4x45, 5x30, 6x25, 8½x7x28.

**MISCELLANEOUS EQUIPMENT**

Hammermills: Jeffrey 36 x 24 ft & 42 x 36 Fitzsouth-Williams 60 GA.
Dings 60"—3 Roll Type I.R. Magnetic Separator.
6', 10' & 16' Mechanical Air Separators.
8 x 6, 6 x 6, 6 x 10 & 7 x 6 Ball Mills.
#0 & #1 Raymond Automatic Pulverizer.
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2—9' x 22' Silex Lined Twin Mills.
8½'-10-8½' x 50' Nodulizing Kiln.
10' x 36" Hardinge Air Classifying Ball Mill.
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1—Bufiovak 6' Jack. Vac. Crystallizer
3—Aluminum Bubble Cap Columns 27" and 36"
6—Bucket Elevators 8' to 40' overall
1—Devine 13 Shelf 40" x 43" Vac. Dryer
1—Stokes 6 shelf 24" x 36" Vac. Dryer
1—Sweetland Filter #12 with 36 Leaves
5—Filter Press 18" to 42" Wd Plate & Frame
2—Sperry 36" Filter Presses, Hyd. Closures
6—Stainless Steel Jack. Kettles with Ag. 100 to 950 gals.
2—Cast Iron Jack. Kettles 250 & 800 gals.
1—Stainless Steel Jack. Mixer 75 gals.
1—Day D-8 Jack. Mixer—800# Cap.
1—W & P Mixer 100 gallon. Sigma Blades M.D.
3—Mikro Pulverizers 2 TH and 2 FF—10 H.P.
1—Gruendler W.B., Jr. 10 H.P., A.C. Motor
1—Robinson Size 1212, Rotary Cutter—10 H.P., A.C. Motor
1—Raymond 16" Screen Mill—5 H.P., A.C. Motor
2—Orville Simpson Rotex Screens 40" x 94" and 40" x 120"
1—Robinson #16 Single Screen 40" x 104"
1—Stokes 43-A Granulator—S.S. Parts
1—Stokes Rotary "DD-2" Tablet Machine
3—Stokes "F" Single Punch Tablet Machines
8—Stainless Steel Tanks 100 to 5700 gals.
3—Horiz. Steel Tanks 3000 to 12000 gals.
6—Stokes 212C Vac. Pumps W.C. 100 C.F.M.

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3 ft. & 4 ft. Stainless Steel Vacuum Pans.
3—32" x 90" Bufiovak Double Drum Dryers.
100 to 250 gal. S.S. Mix Tanks, water jkt.
3000 gal. S.S. Truck Tanks, Trailerized.
100 gal. S.S. Cast Jkt. Kettles, 30" x 52".
150 gal. S.S. Jkt. Kettle, 42" x 36", agit.
300 gal. Pfaudler Horiz. Glass Lined Tank 25#.
4—50 gal. Steel Kettles, 75# Wk., A.S.M.E.
Gruendler Jr. Pulverizer, 10 H.P.
75 to 1500 gal. Homogenizers or Viscolizers.
28" Centrifugal Extractors, copper baskets.
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Model 148C Stokes High Vacuum Pump, 1½ H.P.
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Filter Presses: 24" C.I. plate and frame.
Reactors: 250 gal. stainless steel.
Mixer: Day Cincinnatus #6, 25 hp. jktd.
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Autoclave: 10 gal. Bufiovak, cast iron.
Vacuum Pan: 6' Harris stainless steel.
Vacuum Pumps: Nash Hytor H5, 20 hp.
Powder Mixers: 100 to 2000 lb. capacities.
Mixer: Read dbl. arm, 300 gal., st. steel.
Starch Cookers: 300 gal. Lee stain. steel.
Colloid Mill: Premier 3" st. steel, 7½ hp.
Clarifiers: De Laval 84-51, motor dr.
Glass Lined Tanks: Pfaudler 3000 gal. closed jacketed, dairy type.
Mill: Hardinge 5' x 36" buhrstone lined.

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3' dia. x 1' face, 10 sq. ft. filtering area, complete with all drives, motors and accessory units. Type 316 stainless steel. String or scraper discharge. Used, but in excellent condition. A few new units also available.

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Five body quadruple effect type 304 stainless steel Swenson evaporator, 650 sq. ft./effect complete with heaters, pumps, turbines, etc. Drawings available.

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| Stock No. | Description |
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| 3239-GS | Steel Horizontal Autoclaves or Retorts: 66" dia. x 147" long. |
| 3490 | Climax Rectangular Sterilizer: fully jacketed; 48" x 42" x 96". |
| R4-238 | Steel Jacketed Digester; 2000 Gal., 6'7" x 11'5". |
| T10-251 | Steel Jacketed Rotary Digester; 9'6" x 12'; 100 PSI ASME. |
| T10-250 | A. O. Smith Welded Steel (2") Pressure Tanks: 6' x 40' and 10' x 40'. |
| 1000C85 | Acid Proof Tile Lined Autoclaves: 5'10" x 14' with cone tops and bottoms; 3,375 gals. 100 PSI. |
| T11-252 | Rubber Lined Steel Pressure Tanks: 40,000 Gal. 11' x 56' 50 PSI ASME. |
| V4-260 | Steel Autoclave; 5' x 25'; coil heated with tracks, vac. pump and receiver. |
| R4-226 | Steel Autoclave 6' x 21'; 300 PSI; Jacketed and Agitated. |
| V4-261 | Steel Vulcanizer 6' x 26'; 125 PSI with tracks and trucks. |
| V4-262 | Biggs Vulcanizer, 6' x 14'; 110 PSI ASME; quick opening door. |

**BALL AND PEBBLE MILLS**

| | |
|---|---|
| 3443 | International Type X24 Porcelain Lined Pebble Mills: 8' x 8' with 50 HP. gear motors; also size 6' x 8'. |
| 3501 | Abbe Buhrstone Lined Pebble Mills: 4'6 x 5'; P.D. |
| 3403 | Abbe Buhrstone Lined Pebble Mills: 5' x 6'. |
| M14-195 | Abbe Buhrstone Lined Pebble Mill: 32" x 36" with 2 HP motor. |
| M14-196 | Patterson Buhrstone Lined Pebble Mill: 6' x 10' with 10 HP. |
| M14-197 | H. K. Porter Porcelain Lined Pebble Mill, 5' x 6' with 25 HP. |
| M3-176 | Patterson Chrome Manganese Tube Mill; 3' x 10' with air-classifier. |
| M8-811 | Allis Chalmers Tube Mill, 60" x 22'; silica brick lined. |
| M3-177 | Kennedy-Van Saun Ball Mill: 4' x 8' with Herculite liner. |
| M8-178 | Hardinge Conical Ball Mill: 10' x 36" with Feedometer, etc. |
| M8-179 | Hardinge Conical Ball Mill: 4'6" x 24" with 30 HP. |
| M8-181 | Hardinge Conical Ball Mill: silica block lined; 5' x 36". |

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40" perforated, steel.
40" perforated, SS.
24" Bird, CH. SS.

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8'x36'x¾" Absorption (2—UNUSED).
5'x51'x⅜" Absorption, ASME 20 trays (2).
5'x36'x⅜" Absorption ASME, 14 trays.
3'6"x58'x⅜" Absorption.
6'x14'x2¼" Scrubber, 5" heads 225 PSI.
24"x13' C.I. Fractionating 18 plate.
5'x42'x¾" Packed.
6'x49'x⅜" Bubble Cap, 18 trays.
6'x29'8" Bubble Cap, SS, 21 trays.

**CONVEYORS**

Belt—All widths and lengths.
Screw—12"x80'.
Apron—36"x34'.
Peck Carrier, Link Belt, 36"x36".

**COOLERS**

Spray, 5'x30'x⅜" w/raschig rings.
Sincro, 24"x24'.

**DRYERS**

Tunnel Truck 9'x35'x8', cap. 14 trucks.
Turbulaire N2 Spray, SS, Complete.
Stokes, Rotary, Vacuum, 36"x8', Complete.
Buflovak 5'x6' Atmos. single drum.
Stokes, 4'x9', Atmos. double drum.
Proctor & Schwartz 6'x40' Conveyor Dryer.

**FILTERS**

18" Press, ratchet type, closed del., 11 chambers.
8'x12' Feinc, all steel.
8'x10' Oliver, wood & steel (3).
11'6"x18' Oliver, all steel.
4'x5' Oliver, SS & Wood (2).
27 Sweetland, 2" spacing, 28 leaves. 38", 35 chambers, center feed, open.

**KETTLES**

5,500 gal. aluminum 8'x15'x⅜" agit. (2).
2,350 gal. ASME, jack'td., agit., steel.
2,000 gal., agit. jack'td. 200 PSI. (3).
1,500 gal. jack'td., C.I.
400 Gal., glass-lined, jack'td., agitated.
40 gal. SS clad. 40 PSI, jack'td, (4).

**KILNS—COOLERS—DRYERS**

1108-35 Roto Louvre.
7'x80'x½" with lifters.
6'x14'x9/16" Struthers-Wells (NEW).
5'x67'x5/16" with lifters.
10'x80'x9/16" Allis Chalmers.
4'x35'x½" with burner.

**MILLS**

6'x8' Abbe.
6'x8' Patterson.
GP 106 Williams.
K-200 Kombinator, SS.
4-roll Raymond.
5'x22', tube, Silex lined.
Size 1 Allis-Chalmers.
A2 Jeffrey 24"x18".
Day, 3 roll 16"x40".
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Stedman 36" 4 roll cage.

**MIXERS**

Paddle, 18"x24"x18", complete w/drive.
Paddle, double shaft, 140 cu. ft. (NEW).
Readco 1½ SA, 88 gals.
Blystone, 48"x67", 500 gals. (2).
Binks, type TM80, 100 gals. (2).
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Sublimator, hor., 4'x10'.
Dayton, turbo, 400 gal.
Lightning, 1 to 3 HP.

**TANKS & PRESSURE VESSELS**

135,000 gal. 30'x28' w/coils.
25,000 gal. 10'x40'x⅜" (NEW).
12,000 gal. 8'x32'x¼" (NEW).
10,000 gal. 10'x15'x7/16".
8,500 gal. vert. 8'x23'x5/16" (NEW).
4,100 gal. vert. 5'x28'x¼" (NEW).
3,400 gal. 7'4"x10'x⅜", type 430 SS.
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| 3293 E1 | Raymond Imp. Mill; 9" x 18" complete with accessories. |
| 1001 N1 | Williams Model NF Hammer Mill; 28" x 14" requires 60 HP. |
| 3429 A 7 | Williams Hammer Mill; 30" x 19"; requires 50-60 HP. |
| 3429 A 6 | Williams No. 4 Hammer Mill; 18" x 15"; requires 65 HP. |
| 3429 A 9 | Gump Bar-Nun No. 48 Hammer Mill; 12" x 40"; requires 60 HP. |
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| M10-188 | Jay Bee Shredder Type Hammer Mill with 100 HP. |
| M10-189 | Williams No. 40 Pulverizer with 200 HP motor. |
| M10-184 | Raymond Model No. "00" Pulverizer, motorized. |
| 2383 | Raymond Model No. "00" Automatic Pulverizer with accessories. |
| M10-183 | Jeffreys Type E Swing Hammer Shredder; 42" x 36". |
| 3324 E2 | Mikro No. 4 F Pulverizer; 15" x 24"; requires 40 HP. |
| M10 186 | Mikro Model No. 4 with 75 HP. motor. |
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| M10 185 | Rietz RD18 Disintegrator; Stainless Steel; 50 HP. |
| 3459 | Ball & Jewell Rotary Cutter Model 1½; S.S.; 40 HP. |
| 3168 O 3 | Stainless Steel Saw Tooth Crusher; 10 x 11" with 2 HP. |
| 3447 | Sprout Waldron Saw Tooth Crushers; 16" x 16" and 20" x 25". |
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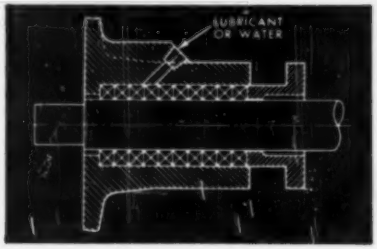
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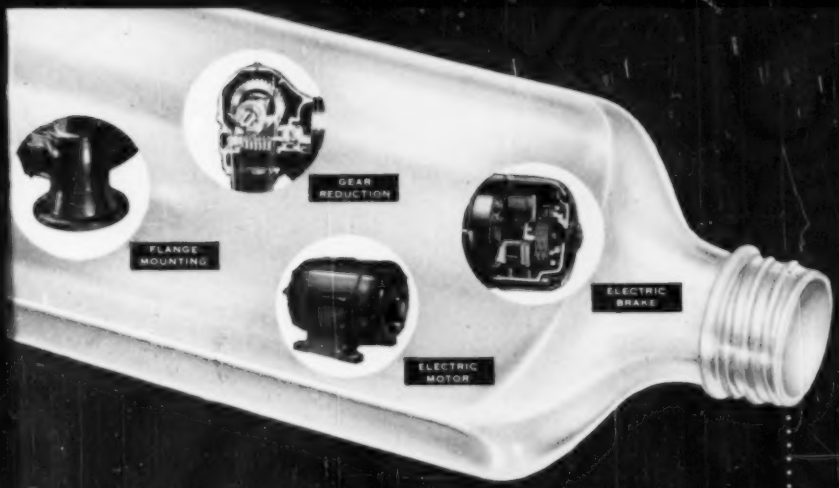
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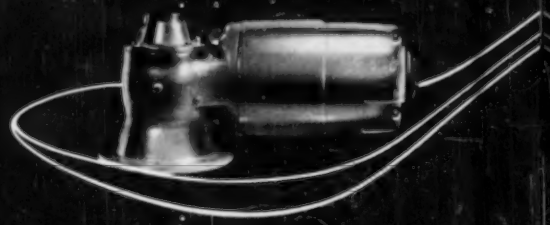

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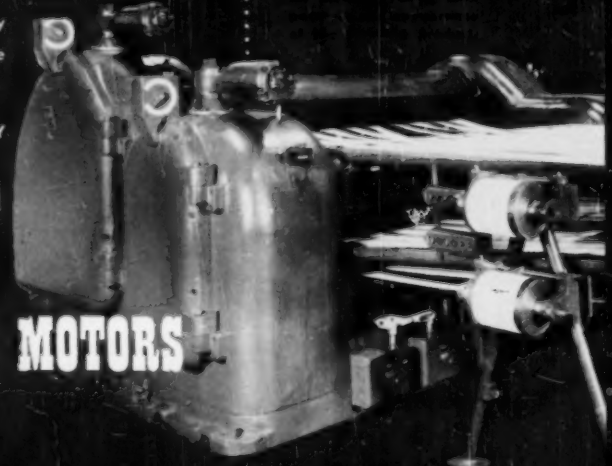
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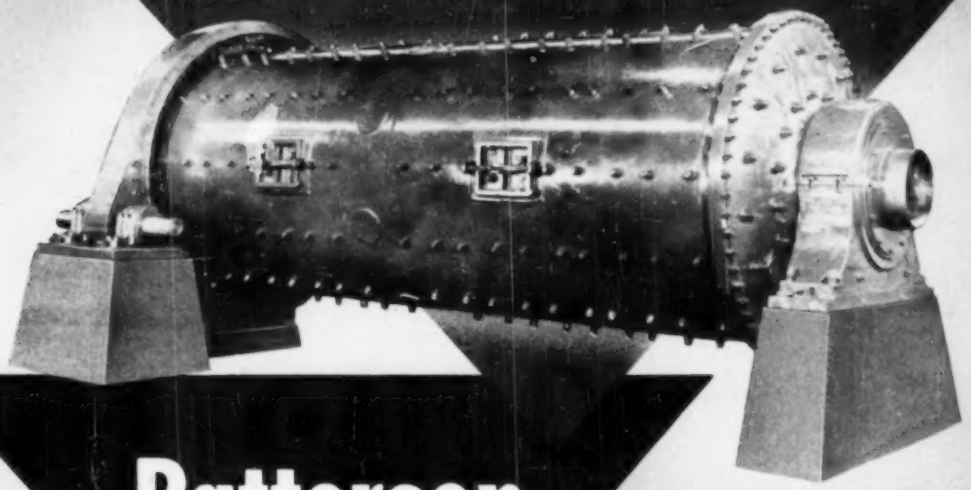


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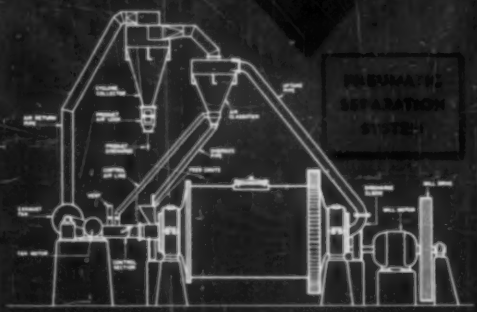
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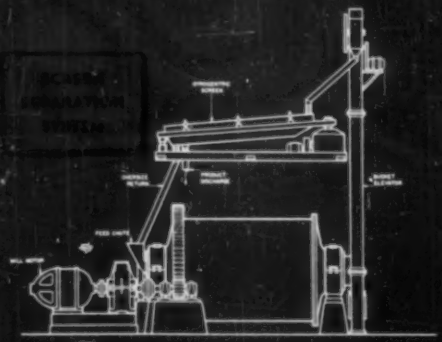


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